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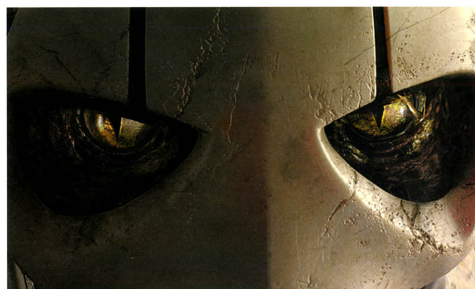
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- 15 **Sin City**
Jody Duncan
- 35 **Constantine**
Joe Fordham
- 57 **Q&A: George Lucas**
Jody Duncan
- 66 **Star Wars Episode III:
Revenge of the Sith**
Jody Duncan
- 98 **The Hitchhiker's Guide to the Galaxy**
Joe Fordham

Cool Cars, Hot Women And Hard Bastard Men

ARTICLE BY JODY DUNCAN

COOL CARS, HOT WOMEN AND HARD BASTARD MEN

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Of the millions of fans who have been drawn into the dark world of Frank Miller's 'Sin City,' none has been more admiring of the graphic novels than director Robert Rodriguez. Since 1991, Rodriguez and fellow Miller-philes have eagerly devoured seven Dark Horse Comics 'Sin City' volumes, each a babes-and-badasses tale of horrific crime and brutal retribution.

Three of those volumes — the debut 'Sin City,' 'The Big Fat Kill' and 'That Yellow Bastard' — provided the source material for Frank Miller's *Sin City*, a Dimension Films and Troublemaker Studios production co-directed by Rodriguez and Miller. Unlike other 'comic book' movies, *Sin City* would not just be based on Miller's graphic novels — it would be a virtual panel-by-panel re-creation of them. "Frank's books were already the best-directed movies never seen on the screen," Rodriguez offered. "They were so well lit, well shot and well acted, I didn't even have to adapt them."

Miller, who had been burned in past associations with Hollywood, had never intended that the 'Sin City' tales be adapted to film, and had, in fact, taken steps to ensure that they would not be. "Frank Miller had sworn off the film industry," recalled Stuart Maschwitz, self-described 'Sin City' geek and visual effects supervisor at The Orphanage, one of three effects vendors on the show. "So when he set out to create 'Sin City,' one of its stated missions was that it would never be turned into a movie. It would be a representation of the pure form of the graphic novel, and so violent, no one would ever want to make a movie of it. During development of other projects, I'd heard it directly from Dark Horse: 'We can talk about any of our properties except 'Sin City.' That's off the table.' Frank just wasn't interested. But then, along comes Robert Rodriguez, who is a huge fan of the books and not the kind of guy who takes 'no' for an answer."

Having secretly longed to translate the graphic novels to film for some time, Rodriguez began seriously mulling over the problem of how to re-create their stark, stylized, high-contrast black-and-white look in cinematic form as early as September 2003. With the intention of finding an answer to that most basic question, Rodriguez shot some preliminary tests while trying out the newest HDSR cameras from Sony at his Troublemaker Studios in Austin, Texas. "Sony was showing us the new 950s," recalled Rodriguez, "and I said, 'Hey, as long as we're testing out the gear, let's grab a couple of shots from this comic' — I didn't tell them why. We did shots of me walking in really white snow, with strange 'Frank Miller' shadows across my face. We shot my sister in a red dress. We shot some of the most difficult images from the books to experiment with the high-contrast look. I knew if I could make those shots work, I'd be able to make all the other shots work." After shooting the HD images, Rodriguez had his Troublemaker Digital team — Chris Olivia, Rodney

Brunet, Alex Toader and John Ford — rough in some crude graphic-novel-style backgrounds. “They weren’t even backgrounds. They were more like vague shapes. But when I took those shots to Frank, he was really startled by the images. He felt like he was looking at movie stills from his comic.”

Rodriguez had intrigued the still-reluctant Miller with his preliminary test images. To engage him further, he suggested that Miller come down to Austin and participate in the shooting of a short test scene — a dozen-panel short story, ‘The Customer Is Always Right,’ featured in a longer ‘Sin City’ novel. “I knew that if he came down to shoot that one scene with me, he’d get hooked and he’d be all over it,” said Rodriguez. “Then, if Frank liked what we did, we could use ‘The Customer Is Always Right’ as the beginning of the movie, and keep going. Even if he didn’t like it and still said ‘no,’ I was so excited about the project and thought it would be so spectacular to put those images on the screen, this would at least give me a chance to get all of that out of my system. If nothing else, I’d have a short film to show myself at the end of the day.”

Over the course of a few hours on a Saturday, and with Miller in attendance, Rodriguez shot the scene against greenscreen, with Josh Hartnett and Marley Shelton playing the roles of ‘The Salesman’ and ‘The Customer,’ respectively. Within a few days, Troublemaker Digital had surrounded the characters with a computer generated city.

Miller was impressed with Rodriguez’s approach, and with his decidedly ‘un-Hollywood’ Troublemaker Studios setup, which consisted of offices and stages housed in a couple of converted hangars at a defunct Austin airport, manned by a very small, but gifted, Rodriguez-loyal staff. More importantly, Miller was delighted with the final shots, which virtually replicated ‘The Customer Is Always Right’ scene as he had drawn it in the graphic novel. To further sweeten the deal, and to assuage any fears Miller might still harbor about turning over his material to outsiders, Rodriguez suggested that they co-direct the film. “I had to convince Frank that it wouldn’t be like the Hollywood experiences he’d had,” Rodriguez recalled. “He wasn’t going to have to go through the whole development process. What development? The books were already developed. He wouldn’t have to go through the process of writing a script, because he’d already written a script — it was right there in the books. It took some convincing, but I knew how to do it, because I come from the same cartoonist background — and it would take a lot to get me to do this to one of my properties!”

Miller agreed to the arrangement. But then, much to Rodriguez’s surprise, the seemingly logical collaboration was illogically rejected by the Directors Guild of America, which cited rules stating only ‘bona fide teams’ could co-direct films. Undaunted, the fiercely independent Rodriguez made good on the name of his company and promptly resigned from the DGA. Using ‘The Customer Is Always Right’ as his calling card, he quickly secured a greenlight from Dimension and commitments from big-name stars such as Bruce Willis, Clive Owen, Mickey Rourke and Benicio Del Toro. *Sin City*, with Robert Rodriguez and Frank Miller as co-directors, was a ‘go.’

Miller was on set every day of the 10-week principal shoot; but even had he not been, his stamp would have been on every frame of the movie, since — to the degree possible — Rodriguez was slavish in his adherence to the graphic novels, using their panels as his only storyboards. “We would try to shoot every panel exactly as it was,” said Troublemaker Studios visual effects producer and postproduction supervisor Keefe Boerner, “and then we would get additional angles. If we had to change something from the way it was in the panel, we always talked to Frank about it first, and explained why it had to be changed. So we did make some minor modifications from the books, but always with Frank’s approval.”

Miller, in fact, was more inclined than Rodriguez to suggest deviations from his original work. “I didn’t want to change anything,” Rodriguez noted, “and I didn’t want to let Frank change anything, either.

During the shoot, he’d occasionally come up to me and say, ‘Why don’t we try a black silhouette shot here?’ And I’d say: ‘Look what you did in the book, Frank. It’s a white silhouette. I think we should do that.’ There is always a tendency to rethink things; but, usually, the initial work is best, and you don’t make it any better when you change it.”

The graphic ‘Sin City’ look that had been developed with the preliminary test shots and ‘The Customer Is Always Right’ scene continued to evolve on a shot-by-shot, day-by-day basis throughout principal photography. In general, the approach was to shoot the actors in color against greenscreen using the new-generation high-definition cameras, then surround them with stylized, digitally-created environments. To depict the pure blacks and whites of the graphic novels, Rodriguez — acting as his own cinematographer — designed and implemented extremely stylized lighting schemes for the greenscreen stage. Postproduction crews then desaturated the color and ramped up the contrast in the final composites.

“We had to shoot the movie this way,” Rodriguez explained, “because of the tricky lighting required to get this really amazing high-contrast look. People were wearing black a lot, for example, and we would have to put many, many edge lights on them to make them pop out of the background — something Frank could do easily just by outlining them in white paint. It wasn’t as easy for us to get that look. We had to light the shit out of them, without seeing the lights all over the place. Shooting on the greenscreen stage, we could place lights anywhere, then design and build backgrounds to justify those light sources. We could use very reflective black materials to catch edge light and burn it out like a white-paint outline. There were all kinds of lighting tricks we had to figure out shot by shot.”



Director Robert Rodriguez’s determination to translate Frank Miller’s gritty graphic novels to the screen resulted in the visually stunning Sin City. Rather than use the novels as mere inspiration for the movie, Rodriguez and co-director Miller re-created them panel by panel, employing digital technology to craft highly stylized black-and-white environments. During early testing, Rodriguez’s own Troublemaker Digital Studios devised the signature ‘Sin City’ look, surrounding greenscreen actors shot in HD with desaturated, high-contrast digital images. Working ‘on spec,’ Rodriguez produced a prologue scene, ‘The Customer Is Always Right,’ which proved the concept and sealed deals with the initially resistant Miller and a cast of A-list actors.

The real-time interactivity of HD, which allowed Rodriguez and Miller to see what they were getting as they shot it, made those shot-to-shot creative decisions possible. Two monitors — one 32-inch and one 24-inch — were hooked up to the main camera, allowing the filmmakers to view shots both in color and in the desaturated black-and-white. “The color monitor told us whether or not we were getting a good signal,” said Keefe Boerner. “On the other monitor, the image was desaturated and the contrast was increased to make it black-and-white. That was how we judged what the final look of the shot would be when it was composited and treated in post.”

Most importantly, the black-and-white monitor helped Rodriguez to determine if the lighting — which might appear appropriate and sufficient in color — held up in the high-contrast image, as well. “It allowed me to figure out if I was adding enough fill into the eyes and other things you couldn’t be quite sure of if you didn’t have that,” observed Rodriguez. The monitor’s larger-than-normal screen size also helped the filmmakers to make those determinations. “One of the things I’ve seen when I’ve watched other people shooting HD is that they have these tiny little monitors. I always think, ‘You guys are cutting yourselves so short!’ One of the main advantages of HD is that you can watch the movie as if you’re at the premiere while you’re on the set. The bigger the image, the more detail you can catch. You can really see what you’re doing before it’s printed.”

Each of the stories — ‘Sin City,’ ‘The Big Fat Kill’ and ‘That Yellow Bastard’ — was shot during its own 15-day schedule, reflecting the filmmakers’ view that they were making three distinct little movies, as opposed to one long film. That philosophy spilled over into the visual effects work, as well, with each story assigned, in its entirety, to one vendor. Hybride in Montreal took on the ‘Sin City’ sequence, CafeFX created shots for ‘The Big Fat Kill,’ and The Orphanage was assigned to ‘That Yellow Bastard.’



The movie intertwines the narratives of three separate graphic novels – the debut ‘Sin City,’ ‘The Big Fat Kill’ and ‘That Yellow Bastard.’ An early scene in the ‘Sin City’ episode introduces the granite-faced Marv (Mickey Rourke) and his new love Goldie (Jaime King), trysting on a heart-shaped bed in her apartment. Like all the scenes in the film, the Marv/Goldie encounter was shot in color on a minimal greenscreen set. Two on-set monitors – one displaying images in color and the other in desaturated black-and-white – helped the filmmakers to determine if extremely stylized lighting schemes employed on set would read appropriately in the final composites.



Hybride – one of three effects companies on the picture, each handling one complete episode – desaturated and ramped up the contrast in the HD footage, then composited it with stylized CG set extensions. Originally instructed to match the pure whites and blacks of Miller's drawings, Hybride – along with the other two effects vendors – eventually introduced some tonality into the shots to soften their stark quality and to retain performance nuances in the actors' faces. As in the novels, isolated color elements were introduced for dramatic effect.



KNB FX partner Greg Nicotero supervised the film's makeup effects, including those intended to transform Mickey Rourke into Marv. The character makeup, initially designed by Scott Patton and patterned after Miller's stark drawings, included multiple facial prosthetics.

Representatives from the effects companies came to Austin to monitor the shooting of their particular episode for periods of a few days to two weeks; but Greg Nicotero and his team from KNB FX were with the production from beginning to end, providing a variety of on-set makeup effects. First up on the shooting schedule was the 'Sin City' episode — also the first of the three stories in the film, after 'The Customer Is Always Right' prologue — which required a prosthetic makeup to transform Mickey Rourke into the battle-scarred Marv.



In addition to creating all of the environments digitally, Hybride added CG rain to many of its 'Sin City' scenes, replicating the stylized, slanted rain in the graphic novels. Because much of the greenscreen footage had been photographed without practical rainfall, Hybride also had to add digital water effects impacting and bouncing off characters' faces and clothing.

Having seen the bottom of too many gin bottles and the inside of too many jail cells, Marv enjoys a reprieve from his miserable life in the arms of the beautiful and mysterious Goldie (Jaime King). The respite comes to an abrupt and bitter end, however, when, after a night of lovemaking, Marv finds his new love lying dead in the bed next to him. To avenge Goldie's murder, Marv goes on a killing spree — a bloodletting that eventually leads him to the powerful Roark family and to his own death in the electric chair.

Rodriguez's instruction to Nicotero regarding the Marv makeup was not to lose Mickey Rourke beneath layers of foam latex. "He wanted to be able to tell it was Mickey Rourke," Nicotero observed, "but he also wanted to keep the spirit of Marv in Frank's drawings. The biggest challenge was to find a look that would do both of those things." Taking guidance from Miller, who sat down with a sketchpad and illustrated the signature Marv look for the makeup effects team, KNB designed and built a set of foam latex prosthetics that included a forehead-and-bridge-of-the-nose piece and a chin appliance. "The makeup changed the shape of Mickey's face and created all these deep creases and lines and scars, but you could still tell it was Mickey." The final makeup consisted of 12 stages, revealing the progressive damage to Marv's person as he engages in a series of brutal fights.

In 'The Big Fat Kill,' Dwight McCarthy (Clive Owen) steps in to protect girlfriend Shellie (Brittany Murphy) from an abusive ex-boyfriend, Jack Rafferty (Benicio Del Toro), and his gang of friends. From Shellie's apartment, Dwight follows the menacing thugs to Old Town, where they are killed by the prostitute/assassin Miho (Devon Aoki). Jack's true identity as an undercover cop means retribution for the girls of Old Town, unless Dwight can erase all evidence of the crime.

To make Del Toro more closely resemble the Jack character as drawn by Miller, KNB designed appliances that gave the actor a more pronounced chin and a longer nose. "It was amazing how much that little bit of change affected his appearance," Nicotero noted. "He walked on the set with his long hair and makeup, and it was like, 'Hey, look, it's Jackie-Boy!'"

KNB's most extensive makeup assignment was for 'That Yellow Bastard,' the story of John Hartigan (Bruce Willis), a cop with a bad heart who takes on one last job before retiring — rescuing 11-year-old Nancy Callahan (Makenzie Vega) from Roark (Nick Stahl), a serial child killer and the son of a powerful politician. When the story flashes forward eight years, Roark is deformed and discolored — the 'yellow bastard' of the title — and still after Nancy (Jessica Alba), now 19 years old and a dancer at a strip club.

KNB artists had to design and build a Yellow Bastard makeup before the late-date casting of Stahl in the role, requiring them to develop makeup tests on generic heads. "We sculpted the head and a distended belly for the character," said Greg Nicotero, "to make him match the graphic novel. He had a full foam latex bald piece for the back of the head, a forehead-and-nose prosthetic, a chin and cheeks. His face was completely covered." As a final step, KNB used a flocker to give the Yellow Bastard beard and head stubble, then painted the character blue — a color that could be more easily extracted from the greenscreen than could a yellowish hue. The yellow coloration would be added in post. KNB also designed a 'stretch-and-stipple' old-age makeup for Willis, as well as Hartigan's signature 'X' forehead scar, both applied on set by the actor's personal makeup artist.

With completion of the shoot, greenscreen plates began arriving at the effects facilities, each of which took on approximately one-third of the 2,000-shot assignment. Because Rodriguez discouraged image-sharing and communication between the vendors — usually mandatory to maintain consistency — each effects team worked without any knowledge of what the other two teams were doing. "I'd worked with all these people before," Rodriguez noted, "and I knew they'd all come up with their own solution to the same creative problem. If those solutions looked a little different, that was fine because that just meant each story would have its own look and feel. It made sense, because Frank's drawing style had changed slightly between each book. By the time he got to the third book, his style had become much more graphic. 'That Yellow Bastard' is stripped down, with very little detail."

Despite the different styles and content of their respective episodes, all three vendors faced a common challenge: achieving the high-contrast 'Sin City' look that had been established in the test shots. Rodriguez's initial instructions to the effects crews was to match, as closely as possible, the pure whites and pure blacks that were so prevalent in Frank Miller's drawings. Ultimately, however, that look was softened and more tonality was introduced into the images. "When it got too high-contrasty," said Rodriguez, "we lost the detail in the actors' faces — especially the eyes. And that



*In 'The Big Fat Kill,' ex-con Dwight (Clive Owen) confronts undercover cop Jack (Benicio Del Toro) to protect his girlfriend and the prostitutes of Old Town. Eager to wear a prosthetic makeup that would alter his features to more closely resemble the graphic novel's 'Jackie Boy,' Del Toro was rendered virtually unrecognizable by the KNB FX team. CafeFX executed nearly 600 effects shots for the episode, referencing classic film noir movies. Like *Hybride* and *The Orphanage*, CafeFX worked independently, blind to what the other two vendors were producing — an atypical effects approach encouraged by Rodriguez as a means of creating a unique look in each of the three storylines.*

meant we lost the emotion, lost the performance. We had some great actors in this movie, doing very nuanced and subtle work; but that was getting obliterated when we went too far with that look. We had to have a point of interest in the characters. We had to have that humanity, otherwise it just looked like a bunch of cartoon cutouts.”

Often, it was the effects artists themselves who initiated the shift from graphic black-and-white to a more photorealistic look. “There were times when I asked for really simple backgrounds,” Rodriguez recalled, “but they would come back with very lush backgrounds. They would model something that had a lot more detail than we needed, but it would be very beautiful; and I knew I could always have them black it out or blow it out later, if I wanted. That’s what Frank does when he draws. He pencils in everything first, all the detail, and then in the inking stage he decides what he doesn’t really need and blacks it out. I could do the same thing, asking the effects guys to simplify the detailed backgrounds they’d given me. But, usually, I was excited by their more detailed images. They kept us from wearing out the ‘Sin City’ look. *Instead of having everything in the movie look jarring and high-contrast, I picked my moments.*”



After a bloody confrontation between the Old Town prostitutes and Jack and his gang, the corrupt cop’s severed head becomes a key piece of evidence that could destroy the ladies’ crime- and law-free existence. KNB designed a dummy Jack head – sculpted by Mitch Devane and built by Alex Diaz – and produced multiples for the 15-day ‘Big Fat Kill’ shoot. Artist Mike McCarty touches up the paint on one of the heads.

As the first vendor to join the show, Hybride was particularly instrumental in defining the look of the effects, developed as the company generated its 699 shots for the ‘Sin City’ episode. It also did some of the earliest work in what would become a Sin City signature — the sparing use of isolated color within the black-and-white world as a means of emphasizing a story point, object or character. *Red blood* on Marv’s face, for example, served the dramatic purpose of arousing empathy for the somewhat unsympathetic character. “In the black-and-white version,” explained Rodriguez, “we completely lost the hell that Marv was going through for Goldie. Because his blood was black, he just looked like he was dirty, and getting dirtier with each fight. You didn’t really feel as if anything had happened to him. So I decided to try making just his blood red, nothing else. Hybride dialed it in, and suddenly it was, ‘Oh, my God, this guy got his ass kicked!’ You suddenly felt the pain, because you could see the *Red blood*.”

Hybride also dialed in color on Goldie’s hair and dress, to make the briefly-seen character more vivid and memorable. “I thought that by keeping more color in her hair and face,” said Rodriguez, “she would make more of an impression right off the bat, in the opening love scene with Marv. That gave me another interesting thing to do in the rest of the story. Marv keeps thinking that he sees her, when he is really seeing her twin sister. So, whenever he sees her in the distance, and he thinks it is Goldie, she is in color. But then, as she comes closer and he realizes it isn’t her, she fades back to black-and-white.”

The majority of Hybride's — and all the vendors' — work would involve compositing the greenscreen characters into stylized computer generated settings. With little or no production illustrations from which to work, Hybride had the creative freedom to develop the look of those environments from the ground up. "We were thrilled by the project because of the freedom that Robert gave us at this design stage," stated Hybride visual effects supervisor Daniel Leduc, a frequent and longtime Rodriguez collaborator. "We had 45 different locations to create; and though they were all based on Frank Miller's drawings, they also reflected our artists' ideas."

Hybride's slate of 3D environments included city exteriors, prison sets, the bedroom setting of Marv and Goldie's tryst, and areas of the Roark farm. "For each environment," explained Leduc, "we made sure that our 3D graphics department rendered them with a lot of details in the shadows, midtones and highlights. At the compositing stage, detail levels were enhanced using puzzle mattes to create black-and-white patterns; although, at times, those details were subsequently removed to preserve the graphic quality and visual simplicity of the books." In addition to its fully-rendered 3D environments, Hybride projected textures over basic 3D geometry for locations seen in only a few shots, and used Photoshop to paint distant backgrounds.

To add life to its shots, Hybride produced animated bullet impacts, muzzle flashes, and flying debris and blood particles. Hybride also modeled and animated vehicles for all-CG shots of cars careening through city streets. "It was fun to build those cool old cars," remarked Leduc, "and rig the models so they would bounce on their soft suspensions like they used to do in the 1950s."

Rain falls on many of the 'Sin City' scenes. Though Troublemaker had shot and delivered live rain elements, much of the rain had to be created digitally to more closely match its stylized look in the graphic novels. "The challenge was to create a big downpour of water that matched the look of the comic books," remarked Leduc. "We used Maya to generate the rain effects, and also the impacts on the CG set. Later, in compositing, we added some of the live rain elements to achieve the look Robert Rodriguez wanted."

Rain was a near-constant element in 'The Big Fat Kill,' as well, featured in 75 percent of CafeFX's 591 shots. "All the rain you see in our segment is CG," commented CafeFX visual effects supervisor Everett Burrell. "The problem with the rain that production had shot was that it was very heavy; and the heavier the rain, the more interaction you should see bouncing off the actors. If we'd used those practical rain elements, we would have had to make all this water bounce and fall off objects and environments and actors. We lightened the rain quite a bit in our digital rain, but still kept the graphic style that is in the books."



Car troubles plague Dwight as he attempts to hide evidence of the Old Town killing spree by dumping a trunkload of severed body parts at a nearby tar pits attraction. CafeFX created the digital environment – the most challenging of the assignment – from photographic reference of the La Brea Tar Pits. CafeFX also modeled and rendered organic-looking dinosaur statuary at the site, and tracked actors – who had been filmed walking on a green-painted floor – into a simulated grassy terrain. Throughout the complex sequence, actors working on bare-bones sets also had to appear to interact with CG trees, plants and vehicles.

Co-visual effects supervisor Jeff Goldman devised a number of digital rain elements — closeup rain, midground rain and various levels of background rain. “We did 90 percent of the rain through Digital Fusion’s internal 2D particle system,” said Goldman. “We generated a bunch of different rain profiles, still using the HD rain footage as a guide, because there were some things they really liked about that rain. We analyzed the look of that rain and created it in 2D, which was the fastest and easiest way to do it. We had a library of rain elements, with varying densities and direction, which the compositors could just grab and add to shots as needed.”

In developing settings and looks for ‘The Big Fat Kill,’ CafeFX elaborated on the graphic novel’s sketchy imagery with a series of illustrations by in-house art director Peter Lloyd. The company also turned to classic film noir for guidance. “The Warner Brothers film noir box set had just come out on DVD,” recalled CafeFX visual effects producer Ed Irastorza, “and we ate that up. Looking at the film noir stuff was really helpful in getting the true black-and-white look. Most ‘black-and-white’ is really white and gray, with some shades of black.”

To guide the shooting of the greenscreen material, CafeFX provided the Austin film crew with temporary shots very early in the production schedule. “The hardest thing with these types of shows,” said Everett Burrell, “is that you get lost very quickly on that greenscreen. You don’t know where south, north, east or west are supposed to be. We have a moon in our episode, for example, but it couldn’t be in every shot. Where is the moon? All of that had to be figured out. So we temped out every shot for ‘Big Fat Kill,’ and those temps were very important in helping production keep track of where things were supposed to be when they were shooting the greenscreen. I call them temps, but they were at a pretty good level — probably only 20 percent from final.”

An entire fictional city was among the settings created by CafeFX, which referenced photographs of urban areas from all over California in modeling its digital buildings and landscapes. Effects artists also extended an interior set — one of only two practical sets built for the show — for a scene in Shellie’s apartment that opens the ‘Big Fat Kill’ chapter. “We built that kitchen set for real,” observed Keefe Boerner, “because we had actors leaning against the doors and there was a long dialogue scene there, with a lot of interaction with cabinets and countertops and a refrigerator. That set just had two walls, a floor, and a kitchen island.”

CafeFX computer generated the remaining areas of the apartment, including a hallway and bathroom, the latter the setting for a sequence in which Dwight shoves Jack’s head into a toilet. “You’d think a bathroom would be no big deal,” said Everett Burrell, “but in this world, everything had to be catered to on a shot-by-shot basis. It wasn’t just building a bathroom and then pointing the camera. We had to build the bathroom and put the lights in a very particular way to give it a stylized feel.”

The Santa Yolanda Tar Pits, where Dwight disposes of the remains of Jackie’s gang, was built from photographic reference obtained by Irastorza and Burrell at the La Brea Tar Pits. As a natural, organic landscape — rather than a hard-edged, geometric cityscape — the tar pits was the most challenging environment on the CafeFX slate. “All we had were these greenscreen shots of actors walking on a green concrete floor,” noted Burrell, “but in the final scene, the characters had to brush up against bushes and trees, their feet had to go behind blades of grass. There was a whole z-depth thing we had to figure out, which was very difficult. Plus, we had to have dinosaur statues all around the tar

pits. One of the story points is that you don't know if the dinosaurs are real or if they are just products of Dwight's imagination; so they had to look real, even though they don't move." For shots of characters within the viscous tar, production had shot the actors high-speed, in a four-foot-deep tank of water treated with black coloring and a thickening agent. CafeFX composited its CG landscape into the surrounding greenscreen. Production shot a sewer sequence in another, more narrow water tank. In post, CafeFX inserted its digital imagery into the greenscreen positioned at one end.

As he had for 'Sin City,' Rodriguez requested that certain images in 'The Big Fat Kill' be in color — such as the bright red and blue of Dwight's and Jackie's prominently featured retro-style cars. "There are three things Frank always has in his books," said Rodriguez. "Cool cars, hot women and hard bastard men. So we had a lot of loving shots of these great-looking cars, just like in the comic. But the cars looked dull in black-and-white. They hit that ugly midtone, and they didn't look like cool cars anymore. So we put the color back in, and they really popped off the screen."

In no episode was color more significant than The Orphanage's 'That Yellow Bastard' segment, with its vividly yellow title character featured throughout. The Orphanage achieved the effect by keying off the blue-painted Nick Stahl and turning him a yellowish hue in compositing. "Extracting that blue area and shifting the hue into yellow was a straightforward thing," said The Orphanage associate visual effects supervisor Ryan Tudhope. "What was not so easy to figure out was how much detail we needed to preserve in the highlights and shadows of the makeup. Robert really wanted it to feel gritty and dark; so we pushed it through different curves, pulled different channels and plugged them into other channels to get that kind of griminess and things like darkness under the eyes. Details like that made him look like a real character, rather than some plastic yellow thing."



In 'That Yellow Bastard,' Bruce Willis plays cop John Hartigan, who allows himself to be framed for the murder of several young girls as a way of protecting the still-at-large killer's last intended victim, 11-year-old Nancy Callahan. Years later, released from prison and fearing for the now-grown girl's life, Hartigan goes looking for Nancy at her apartment. The greenscreen setup for the scene featured only a doorway frame and a few spare props strewn around the stage.



In the completed shot, created by The Orphanage, a CG setting evoking the look and feel of the graphic novel filled the frame. In addition to replicating the source material's high-contrast black-and-white environments, Rodriguez re-created exact 'camera' angles drawn originally by Frank Miller. The graphic novel panels, in fact, served as production storyboards. Rodriguez and Miller altered the panels or shot additional angles only when absolutely necessary to clarify the action.

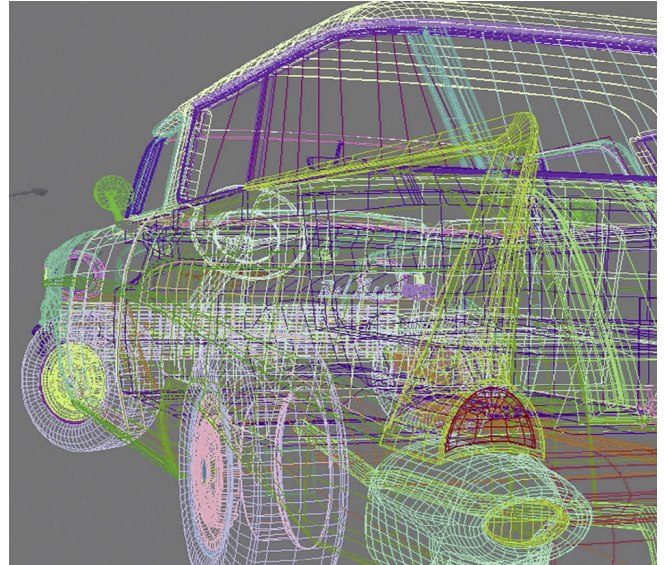


For a scene in which the Yellow Bastard (Nick Stahl) engages Hartigan in a car chase through a snowy landscape, The Orphanage photographed a miniature covered with baking soda, then projected those still images as textures onto a CG model. The landscape was then detailed with matte-painted elements. The cars were CG. All three episodes featured retro-style vehicles, created as digital models and often colored in rich, bright hues to make them pop on screen. Rodriguez used color sparingly in the film to add visual interest or to highlight specific characters and objects.

The Orphanage completed nearly 600 shots for ‘That Yellow Bastard,’ the biggest chunk of work the facility had ever taken on. Company principals had kept in touch with Rodriguez ever since working on his *Spy Kids* 3D. “When we heard he was doing *Sin City*,” commented The Orphanage producer Marc Sadeghi, “we began gunning for the opportunity to be involved in some way. We let Robert know that there were a lot of ‘*Sin City*’ fans at The Orphanage. He sensed that this would be a project of passion for us, and that’s how we came aboard.”

Like those at Hybride and CafeFX, the artists at The Orphanage were encouraged to develop their episode’s style and look independently. “In my first conversation with Robert,” recalled Stu Maschwitz, “I asked him, ‘Okay, how far are we going to push this graphic novel look?’ What the exact recipe for this look was going to be was still being explored, even as we began to receive plates. Fortunately, Troublemaker was working on the problem of the look, and had taken a couple of shots from ‘*Yellow Bastard*’ to show us. One was where Hartigan walks out of prison. They’d done it so that it was completely blown out to white, sinking into black in the walls of the prison, with just enough detail to suggest it’s real. It was extremely faithful to the comic book, and we re-created that when we redid it as the final shot.”

Other environments on The Orphanage slate were rural roads outside the city leading to the Roark farm, the farm itself, including the interior of the barn, and a dock area for the flashback scene in which Hartigan rescues Nancy from a waterfront warehouse. Fore-ground buildings and dock structures were textured 3D models, surrounded by digital water, with matte-painted imagery moving off to the horizon. Though The Orphanage created such extensive 3D settings for scenes numbering 50 or more shots, environments involving fewer shots were always matte painted. “We would go in and do one painting,” said Ryan Tudhope, “then, based on that painting, we would do the other four or five



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views we needed for the handful of shots in that environment. That was a lot more efficient than fleshing it all out in 3D.”

Whether 2D or 3D, all of the shots were designed to suggest a real-world source, as if subject to the same physical limitations and problems a filmmaking crew tackles on a live-action set. “We built artifacts into our CG that you usually only get through a happy accident in live-action photography,” explained Maschwitz. “For example, if we were putting a light at the edge of frame to rim-light a character, and it was a nighttime exterior, we would add a little glow in the air from that light. We added camera shake to shots, we added aperture flares from bare lightbulbs. Movies we all know and love have a bunch of things like that in them, things that don’t happen for free in CG. But they are the cold, hard realities that we would have to work through if we were gaffing the scene for real, and I wanted my CG lighters to work through those same realities.”

A high percentage of The Orphanage’s shots featured snowscapes, some fully rendered in CG, complete with subsurface scattering, others created from practical elements. “On a black duvatyne table,” recalled Maschwitz, “we would sprinkle baking soda on a miniature set and spritz it with water. The matte painters had a collection of toy cars that they would drive around to make tire tracks. They also had action figures wearing the right kind of boots so they could make shoeprints in the snow. Then we’d shoot that set at a couple of different exposures to get a high dynamic range photo that we would use as the basis for a matte painting. We could also integrate it into our 3D pipeline by texture mapping it onto some match-modeled geometry. Then, because of the way our global illumination renders work, that illuminated photographic snowscape became a light source in the frame. It was actually integrated into the global illumination solution.”

To achieve more dynamic snow turbulence — such as that kicked up in high-speed car chases and crashes — The Orphanage installed a Houdini pipeline. Wide shots of speeding vehicles were all-CG, featuring cars that digital artists modeled and animated to interact with the snowy terrain. In other shots, the company composited greenscreen car elements that had been shot by production into its digital environments. For a shot of Hartigan and his partner Bob (Michael Madsen) in a police car, production dollied off the actors in a practical car and toward the greenscreen. “The secondary plate for that shot started from far away,” explained Maschwitz, “dollying into the stationary Yellow Bastard car, which was supposed to be following them at a distance. We had to matchmove those two shots, make a camera move that integrated the two of them, and put the environment around the whole thing, matching the pools of light that they’re driving through to the interactive lighting that they had flashing across the cars on stage.” For some shots, cars were mounted on a Lazy Susan device, then spun toward camera as the camera craned down and pushed in. “Robert’s little green ninjas would be out there pushing the car in its little arcing motion; but then it became this cool crane move, with us starting from farther away and adding travel to it.”

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When *Sin City* opened in theaters during the first week of April, Greg Nicotero — one of the handful of crew members to see, first-hand, the empty greenscreen stage in which the movie had been shot — was awed by the richly detailed images in the final film. “If I hadn’t been there and seen it with my own eyes,” Nicotero observed, “I wouldn’t believe that 90 percent of this movie was shot on greenscreen. I just wouldn’t believe it, because the visual effects and the backgrounds are so stunning. There is one shot that really exemplifies what was done with this movie. It is a shot of Bruce Willis running, then stopping and falling to his knees with chest pain. All that was there, initially, was Bruce Willis running on a treadmill on the greenscreen stage, then stopping and kneeling down. But in the finished shot, he is running through a forest at night, interacting with wind and trees and snow. It’s an amazing shot, because none of that was real.”

With its artful combination of greenscreened live-action and digital environments, *Sin City* follows the current *Star Wars* trilogy and *Sky Captain and the World of Tomorrow* as another step toward a new approach to moviemaking — an approach that, on its surface, appears cold and clinical, but may in fact mark a return to hand-crafted films driven by a single vision. “This was the best possible project to work on,” concluded Rodriguez, “because there was so much freedom in doing it. Most people think that doing this kind of movie is all about the technology and that it doesn’t allow you any freedom. But really, it’s just the opposite. When you do a real movie, you’ve got to go to locations, and here comes the army of trucks and people and equipment — it just ruins the whole vibe. But there is a lot of freedom in crafting a movie on a single stage. Doing *Sin City* was like going back to my days of drawing cartoons, when I could go anywhere in my mind and create a whole world just sitting in a room.”

Sin City photographs copyright © 2005 by Dimension Films. All rights reserved. Production still photography by Rico Torres. Additional photos courtesy of *The Orphanage* and KNB FX. Special thanks to Keefe Boerner, Sandra Conditto, Rama Dunayevich, Sylvie Talbot and Vange Ingan.



For the segment’s vividly-yellow title character, *The Orphanage* keyed off a blue-painted Nick Stahl and introduced the yellow hue in postproduction. On the greenscreen stage, the actor wore a KNB prosthetic makeup that covered his face entirely and also featured a potbelly appliance. The makeup’s blue coloring made for an easier extraction from the greenscreen.



The killer holds Nancy Callahan (Jessica Alba) at knife-point. To avoid a plastic-toy appearance in the yellow-tinted character, *The Orphanage* added organic-looking details to his skin, such as grime and dark circles under his eyes.

Highway to Hell

ARTICLE BY JOE FORDHAM

Occult cinema has had a checkered history in visualizing demonic forms, its grandiose reveals of the creatures often deflating suspense rather than providing a satisfying climax. The relative success and failure of past horror films in depicting otherworldly realms and their inhabitants became a topic of conversation when director Francis Lawrence and visual effects supervisor Michael Fink began planning visual concepts for the supernatural thriller *Constantine*. “In these types of shows,” noted Fink, “there is almost always a decision early on not to show very much, to keep creatures in darkness; and then, some of the darkness lifts — which is not a bad thing, because if you are too mysterious, you end up not telling the story. The darkness gets exchanged for a different kind of drama.”

Highway to Hell

ARTICLE BY JOE FORDHAM



First-time feature director Francis Lawrence brought Alan Moore’s horror comic *Hellblazer* to the screen as *Constantine*, an adult supernatural thriller that followed the exploits of chain-smoking exorcist John Constantine (Keanu Reeves), who has the ability to witness supernatural events in the mortal world. Visual effects supervisor Michael Fink strove to represent demonic imagery inspired by modern art and forensic pathology, with a depiction of Hell reminiscent of atomic bomb blast footage. Stan Winston Studio created creature designs and makeups, while physical effects supervisor Allen Hall devised practical interactive effects. Tippet Studio and ESC Entertainment led the digital effects initiative.

Screenwriters Kevin Brodbin and Frank Cappello adapted *Constantine* from a 1985 DC and Vertigo horror comic, published as *Hellblazer*. The story centers on chain-smoking exorcist John Constantine (Keanu Reeves), who becomes embroiled in an investigation into the apparent suicide of Isabel Dodson, the mentally disturbed twin sister of police detective Angela Dodson (Rachel Weisz). A serpentine series of supernatural events eventually connects the women to the discovery of the *Spear of Destiny*, an ancient relic that killed Christ and now threatens to unleash the son of Satan into the mortal world.

Striving for a contemporary visual style, the production conceived Hell — which would be visited repeatedly in the film — as a parallel universe that coexisted with present-day geographical locations.

“If you were sitting in a living room in Hell,” stated

Fink, “it would be a normal living room, except that it would be nasty and hellish. We didn’t want flames and guys with little forked tails, but we did want Hell to be a violent place; so I suggested to Francis and his production designer Naomi Shohan that we look at atomic bomb footage.”

Conferring with visual consultant Peter Kuran, whose documentary *Trinity and Beyond* had included archival atomic weapon test footage, Fink assembled a reel that showed vehicles and buildings being subjected to atomic blasts. The footage revealed that the first thing to hit, before the shockwave, was a heatwave. “A bus would lean first, then the tires would suddenly turn to black smoke and the paint would be incinerated off — all before the bus was blown apart by the shockwave. Houses did the same thing. I suggested Hell was that moment before the shockwave hit. It was a heatwave in perpetuity, where everything was eroding and burning, with an awful, sulfuric wind that was not fiery, but intensely hot.”

Hell’s inhabitants would also have a real-world basis. The filmmakers brainstormed demon concepts with Stan Winston Studio co-supervisors John Rosengrant and Shane Mahan, who eschewed medieval interpretations of demonic entities to explore pathology reference and modern art. The work of photographer Joel-Peter Witkin — in particular, a series of photographs of autopsy cadavers posed in bizarre and unsettling configurations — served as a major source of inspiration. “In one really compelling image,” Fink remarked, “a corpse was sitting there, but everything above its eye sockets was gone, leaving just an empty bowl. It was very bizarre and pathetic.” The image became the basis for a ravenous ‘scavenger’ demon. “If you’re in Hell, you’re doomed to be perpetually consumed by these creatures; but they’re really pathetic, like beaten dogs who must either feed or starve.”

Stan Winston Studio concept art director Aaron Sims designed the scavenger demon and a legless, winged variant known as a ‘seplavite’ in Photoshop, then, with Jason Matthews, sculpted 3D



Constantine’s first journey into Hell is depicted as he recounts a youthful suicide attempt, which temporarily transports him to an afterlife environment ravaged by something akin to a perpetual thermonuclear heatwave. Tippett Studio created all visions of Hell by transforming contemporary locations into decaying vistas caught in an unending loop of destruction. Digital artists layered matte paintings, 3D geometry and volumetric effects to create a sense of intense heat and constant erosion. Animation cycles depicted palm trees igniting and swaying without physically deteriorating, while streaming particle effects created the impression of paint vaporizing from surfaces.

versions in Softimage as the basis for full-scale maquettes. “The winged creatures were always going to be CG,” related John Rosengrant, “but the maquettes gave us real lighting and texture reference.” Artists used the 3D data to produce computer-numerically-controlled life-size reproductions of the characters, milled from urethane foam. “CNC gave us good form. It didn’t reproduce all the nuances or all the undercuts, but it was carvable and nice to sculpt with. If we needed to bring out any details, we added clay.” The sculpts were molded and cast in silicone, resulting in a five-foot-nine-inch fully fleshed and poseable seplavite and a six-foot-four-inch rod puppet scavenger, with radio control face, jaw mechanisms and cable-controlled finger articulation.

As creature and makeup effects took shape, Ron Frankel’s previsualization studio, Proof, generated 3D animatics of visual effects sequences, with previz supervisor Rich Lee installed in the Los Angeles production office. Mike Fink and visual effects producer Donna Langston — joined by visual effects producer Denise Davis in postproduction — assigned more than 600 visual effects to a battery of vendors, including Tippett Studio, which created Hell, and ESC Entertainment, which handled a number of demon apparitions. Allen Hall supervised physical effects, accompanying the L.A.-based shoot.

The film opens with an unnerving supernatural effect, as a Hispanic transient (Jesse Ramirez) discovers the *Spear of Destiny* in the ruins of a burnt-out Mexican church. Clutching it and walking out into a road, the young man is hit by a speeding car and, miraculously, stops the vehicle dead. Filmed at an abandoned iron mine in Eagle Mountain, California, the shocking impact was shot live. “We originally considered doing the crash CG,” commented Fink, “but Francis and I felt it was much more effective to use the dynamics of a real car, and to put the car and the guy together afterward, replacing any necessary parts with CG.”

Ramirez first performed the scene without the car; then, for a second pass without the actor, Allen Hall’s team inserted an 18-inch-diameter steel pole into a receiver plate buried in the road and installed two powerful high-pressure hydraulic air rams off-camera. Technicians connected cables to a specially prepared car, its engine and windshield removed, and the body weakened to crumple at precut stress points. The camera repeated the pan it had executed on Ramirez, and air rams tugged the car 35 feet at 60 miles per hour, slamming the vehicle into the pole.

Lawrence covered the impact in one take, shooting 24 frames per second, with additional cameras shooting at higher speeds. ESC shot high-definition images of the automobile and performer and used a clean pass to help blend elements. “The metal buck that the car crashed into was gigantic,” remarked ESC visual effects supervisor George Murphy, “so by



The film opens with the discovery of the *Spear of Destiny*, an ancient relic that killed Christ, which imbues a Hispanic drifter (Jesse Ramirez) with a noxious evil influence that fells a herd of Mexican steers. Stan Winston Studio generated subtle transforming prosthetics for Ramirez, who strolled through an empty field. Hydraulx generated a completely digital herd of 3D cattle with bone, muscle and fur simulations, and animated cows to fall and transition from ‘fat, happy’ cows to ‘skin-and-bones’ cows to beef-jerky ‘meat’ cows using procedural ‘rotting’ textures and scorching grass effects replicated across the field.

the time we'd painted that out, we had to replace such a large area that we ended up building a CG hood that we could crumple dynamically."

ESC animated the impact using a digital double of Ramirez, built from a cyberscan and photographic survey, then scaled to size. "Jesse was fairly slight," related ESC co-supervisor Greg Juby. "From camera point of view, he felt the wrong scale to the car; so we enlarged him almost 40 percent. We had a cloth simulation on his body, with 3D glass bouncing off the crinkles in the hood." Unwanted flying debris was painted out in compositing. Compositors also added rendered particle smoke elements.

After the prologue, *Constantine* is introduced exorcising a young girl (Jhonna Trias) who is first seen clinging like an insect to her bedroom ceiling, possessed by supernatural force. Attached to the ceiling of the soundstage set via a harness, Trias wore a gelatin prosthetic — generated by Stan Winston Studio and applied in collaboration with makeup department head Ve Neill — to create the girl's demon-possessed look. "We went with gelatin because of the closeup nature of the scene and the fleshiness of the look," stated Shane Mahan. "We gave her a forehead piece, teeth, contact lenses and an airbrush paint job over her whole body."

The creature effects team also supplied an animatronic head-and-shoulders dummy of the unconscious girl for a brief cut in which the scavenger demon within pushes through her skin. "We didn't want to cut to a lifeless replica," said Mahan, "so we put a little bit of life in her nostrils, gave her a breathing device, and made her eyes twitch beneath her closed eyelids. It was always the intention that whatever we did would be digitally augmented to keep it moving." Tippet Studio created the demonic extrusion, referencing photographic studies of a scavenger maquette pushing through latex. "The most challenging part," said Tippet visual effects supervisor Craig Hayes, "was getting the skin to deform realistically. With the demon poking two feet out of the girl's neck, any technical skin simulation would have choked because it was so extreme."

Constantine dispatches the demon by exposing the possessed girl to a full-length mirror suspended over the bed, catching the demon in the reflection. Tippet Studio created glimpses of the demon in the glass by layering the digital creature behind a thin veneer of antique mirror surface and blending natural reflections with a hint of Hell. Physical effects used an overhead track and an air ram to flip the glass and fly it through a fourth-floor window, filmed outside the Olympic Hotel in downtown Los Angeles. Tippet Studio shot reference photographs of the hotel exterior and used the images to blend into interior window views shot on the soundstage with a white cyclorama outside the window. For the exterior fall, digital artists matchmoved the practical mirror and replaced its surface with a swirling background of exterior imagery and the animated



John Constantine exorcises a young girl (Jhonna Trias) who has been possessed by an evil force. Stan Winston Studio produced a gelatin forehead prosthetic for Trias, as well as dentures, contact lenses and an airbrush body paint job applied in collaboration with makeup department head Ve Neill. Stan Winston Studio also fashioned an animatronic head-and-shoulders dummy of Trias for a brief cut of the girl's neck distending, pushed out by a demon trapped beneath her skin. Tippet Studio extended the effect

demon, adding live smoke and shattering elements on impact.

digitally, referencing studies of a Winston demon maquette pushed through latex.

Constantine continues to be plagued with demon entities, such as the shambling figure seething with bugs that appears to him on the streets of Los Angeles. “‘Vermin Man’ was made out of crabs, rats and about 20 different kinds of bugs,” explained Mike Fink. “Crabs were useful because their big front claws served as thumbs, and the four legs on each side served as fingers, which made a pretty scary hand.” Serpents formed tendons in the demon’s arms and neck; termites formed a coat and pants; and fluttering metallic green tropical beetles formed eyes.

Stan Winston Studio developed Vermin Man concept sketches referencing the surreal portraits of 16th-century painter Guiseppe Arcimboldo, who depicted characters formed out of fruits and vegetables. Key artist Trevor Hensley then produced a sculpture based on the artwork and life reference. “We made castings and molded real insects,” said John Rosengrant, “as well as snakes, a bit of a raven’s head, frogs — whatever we could get from biological supply houses. Then we sculpted them into the design.”

Creature performer Larry Cedar wore the Vermin Man mask in conjunction with an intricate wardrobe created by costume designer Louise Frogley, providing lighting reference on set and enabling one long shot of the creature with minimal digital enhancement. ESC took reference photographs and measurements of the creature, then embarked on research to depict the CG assailant and his complex swarming motions as he broke apart and reformed, evading *Constantine*’s grasp. “The swarming motion had to work independent of the main character motion,” said Greg Juby. “We knew we needed a robust animation system, like the crowd simulations in *The Lord of the Rings*, but the foundation of the movement was an animating surface.” Base character animation depicted Vermin Man’s actions, then creature rigging artists interfaced with effects animators to develop individual creature behavior and apply creatures to the anthropomorphic form. “We solved the ‘grounding’ problem by dividing animation into hero creatures and filler creatures. We animated hero snakes and rats and crabs by hand; then all the other animation moved around those shapes.”

For closeup talking shots, ESC animation supervisor Rick Glen oversaw keyframe facial expressions, millipede lips and flapping beetle eyes. Digital artists then applied a ‘bug patch’ system that enabled effects animators to populate the surface with chunks of moving creatures. For wider shots, animation broke down into face, body and coat. “The face was composed largely of bug patches that were entirely hand-animated to construct specific facial shapes,” George Murphy explained, “then we overlaid procedural bugs on top of that to glue it all together. Each creature had a set of rules for how it interacted with other creatures — so if a snake was moving one way, and a rat was moving another, a cockroach riding on the rat could hop over to the snake and inherit that motion. Adam Martinez wrote an isosurface tool so we could shrink-wrap all the creatures, then add more on top.” Particle simulations enhanced with keyframe animation yielded shots in which the demon explodes and reforms.



On the streets of Los Angeles, Constantine is menaced by a shambling demonic entity comprised principally of bugs. Stan Winston Studio designed 'Vermin Man' and created a full-scale head sculpture, sampling castings made from taxidermy specimens. Creature performer Larry Cedar portrayed Vermin Man on set wearing a mask and wardrobe created for lighting reference. ESC Entertainment then brought Vermin Man to life using complex digital modeling and creature animation. Digital artists developed individual creature behaviors and applied them to Vermin Man's humanoid form, with keyframe animation of writhing millipede lips and flapping beetle eyes.



Grappling with Constantine, Vermin Man disassembles into his constituent parts and then quickly reforms. ESC defined the character's base performance in keyframe animation, then added layers of procedural bug behavior, shrink-wrapping surfaces using an isosurface tool, and added final bug layers on top. Swarming particle simulations were rigged to inherit the motion of the base performance, and were rendered in multiple passes with iridescent textures. When the sequence grew later in production – after the closure of ESC – Tippett Studio created additional Vermin Man shots, retooling elements, and intermingled its effects to complete the assignment.

The effectiveness of Vermin Man convinced the production to commission additional shots late in postproduction, after the closure of ESC. Tippet Studio, which inherited the new work, retooled elements to intermingle its effects with ESC's, prioritizing assets, de-rezzing models and converting texture maps into its RenderMan pipeline. "We used our own human model for the base of the Vermin Man puppet," said Craig Hayes, "retaining as many original elements as possible. We blocked the sequence using a low-rez particle system so animators could see the dramatic beats we were trying to hit. We then mixed in all the processes — ground swarms, aerial swarms and hand-animated bugs, in addition to the main character rig so animators could move really fast. We used in-line archiving inside Maya so we could see a relatively low-resolution version of the character; then, as soon as we rendered it, all the higher-resolution detail came into play." Tippet Studio artists guided the bug behavior using spheres of influence that modulated swarms, taking cues from the keyframe animation.

The sequence concludes as *Constantine* employs a small box containing a 'screech beetle' to repel the demon into the path of an onrushing van. "It was a great splat shot," said Hayes. "We had a camera inside the van and created a big combination of artwork and particles to smear bugs all over the window. It only lasted 14 frames, but it was very visceral."

Seeking an explanation for the demon appearances, *Constantine* visits Papa Midnite (Djimon Hounsou), a voodoo practitioner turned nightclub owner who offers safe haven for angel and demon half-breeds in human form. Half-breed presence was suggested with digital glowing eye effects — yellow-gold for angels, red for demons — generated by Furious FX. "We showed glowing eyes selectively to identify who was who," related Furious visual effects supervisor David Lingenfelser. "We worked mostly in Apple's Shake and created two concentric mattes inside the iris — a hard matte in the center to create a solid red or gold, and a softer matte around that to fade out that color, to make it feel deeper in the eye. We then added 2D hand-drawn highlights, kissing the edge or the center of the pupil, to make it feel like light was rolling over the surface."



To fend off a later demon attack, Constantine wields a fragment of holy cloth that ignites to create a blast of supernatural energy, dispersing a flock of savage winged 'seplavite' demons. Stan Winston Studio generated the demon design and fashioned a full-scale, poseable seplavite maquette for lighting reference during the shoot in downtown Los Angeles. The physical effects team supplied Keanu Reeves with an illuminated glove to produce flickering interactive light effects on set. Tippet Studio digitally enhanced the practical effect and created animated seplavites that incinerate and scatter in a frenzy of flapping wings.

Demonic intrusions become more overt in a later scene in which a flurry of black shadows flies past Constantine's apartment, rattling the shuttered windows. Tippet Studio animated the shadows, augmenting a physical effect. "We had vibrators in the walls so everything would shake," said Allen Hall. "Each shaker had an acentric weight attached to a motor, and we had 12 of them positioned behind the wall, rattling the length of the apartment so the shaking came from one end towards Keanu."



In a chilling flashback scene, Constantine relates childhood memories of seeing demons in all walks of life, including an elderly bus passenger who withers to her true demon form, visible only to young Constantine. Tippet Studio created the disturbing apparition, tracking animated textures to actress Barbara Pilavin's face. Stan Winston Studio then created a subsequent shock effect of a second demon, filmed on location, who suddenly leers into frame behind the boy wearing silicone prosthetics closely patterned after forensic photos of a three-week-old corpse.

Outside, the unseen demons pursue Dodson and Constantine, blacking out street lamps all around. Director of photography Philippe Rousselot orchestrated the effect in downtown Los Angeles. "We didn't have the budget to re-light city blocks in CG," stated Mike Fink, "so we did it practically by replacing lamps in streetlights along two blocks. Philippe's guys controlled illumination using dimmer boards on set." Computerized traffic signals, however, could not be similarly orchestrated. "Even if we could have turned them out, we couldn't have turned them out on cue. And then, turning them back on for Take 2 would have taken half an hour." Fink commissioned Pacific Title to remove traffic signals digitally, illustrating timings in a rough After Effects composite created from an Avid cut of the scene. "There was a huge amount to coordinate. We had wetted-down the set, so not only did we have to turn out traffic signals, we had to get rid of their reflections. Every light reflected in the street, on the sides of buildings, in windows, in the characters' eyes — they were reflected everywhere!" Pacific Title created matte paintings of clean frames and articulated mattes to blot out lights, per Fink's timecode cues.

Constantine and Dodson fend off creatures in the shadows using a fragment of holy cloth, known as a 'Moses shroud,' which ignites and reveals a horde of seplavites. On the set, Stan Winston Studio artists hung their seplavite maquette as reference, while the physical effects crew supplied practical light sources to simulate the intense flare of the Moses shroud. "We made a glove covered with high-powered yellow and red LEDs," said Allen Hall. "The lights were computer controlled with a wire running down Keanu's sleeve, and when he held them up, we made them flicker in a wild pulsing flame cycle that lit his face and the wall behind him."

Utilized in conjunction with a remotely-operated lamp-on-a-stick for brighter glows, the practical light sources gave Tippet Studio cues to illuminate the flock of ferocious seplavites, animated with vultures and bats as reference. "They had to be frightening," noted Craig Hayes, "but there had to be a pathetic quality to them, as well. They were really victims, and that had to come across in their flying." The creatures ignite, scorched by the cloth, and disperse in a frenzy of light and flapping wings, accentuated in the composite by amping up the flicker of the onset lighting.

The seplavite attack inspires *Constantine* to perform a ritual that transports him from Dodson's apartment to the nightmarish parallel domain of Hell. CIS Hollywood set up the scene with an establishing shot of Dodson's apartment building at night — realized as a digital matte painting constructed from a live-action plate of the 101 Freeway, and enhanced with photographic tiles of Los Angeles projected onto 3D geometry. Subsequent scenes inside Dodson's home, filmed on a Warner Brothers soundstage, featured CIS composites of the freeway outside the window, reinforcing its proximity as it corresponded to the layout of Hell devised by Tippett Studio. "Constantine starts his journey in Angela's apartment next to a freeway facing south," explained Craig Hayes. "We wanted to make sure we were working with that continuity. I'm very big on creating an overall worldview and sticking to it, so we could be sure that Francis and Mike were happy with how far away the city looked and what buildings were recognizable, like the Capitol Records building or the First Interstate tower downtown."

Naomi Shohan designed the Hell freeway set to fill a soundstage — six lanes divided by a center median, extending 60 by 80 feet. A greenscreen surrounded three walls of the set, which was crammed with destroyed automobiles dressed with latex and rope fiber simulating blistered paint. The production investigated practical atmospheric effects filmed against a brown muslin backdrop, but ultimately shot Reeves with only wind machines blowing, relegating all other atmospherics to digital creation.

Flying dust effects required both simulations and keyframe animation. "Dust simulations alone weren't enough to create the types of erosion we needed," said Tippett CG supervisor David 'Grue' DeBry. "Character animators controlled how surfaces eroded and how the dust flew through the air, especially around characters. Effects animators controlled how dust flew off a surface, how surfaces were revealed, how dust moved through the air and around objects. We found pretty quickly that a single dust solution was going to be too computationally heavy, so we used different dust systems that transitioned into one another."

Tippett Studio added layers of digital matte paintings to define the Hell horizon, brought to life by volumetric effects. "There was constant erosion, with objects organically growing into one another in a state of decay," observed Craig Hayes. "The whole environment was populated with so many layers of



Scenes transpiring within the irradiated landscape of Hell were photographed in a soundstage set designed by production designer Naomi Shohan to represent a portion of the 101 Freeway in Los Angeles, dressed with wrecked automobiles and surrounded by three walls of greenscreen. The physical effects team experimented with practical, in-camera effects of falling dust and ash to simulate the turbulent atmosphere, but the filmmakers ultimately elected to shoot Hell scenes with interactive wind machines, capturing clean background plates with diffuse lighting to enhance flexibility in digital composites.



different types of eroded material, it meant huge rendering challenges to build up detail from extreme foreground to the horizon.” To streamline the complex environment, Tippett Studio designed animated cycles of repositionable elements. “We had palm trees being blown in a superheated nuclear wind. We created animation cycles long enough so we could run them for 2,000 frames, and offset animation of adjacent palm trees so it was not obvious that they were portions of the same cycle.” Physical decay was implied rather than animated literally. “In our early tests, we found that making objects appear to visibly decay in wide shots produced a very confusing image. So instead of that, for the most part we chose to indicate decay by streaming particle effects. The drama was not about the place falling apart as much as it was about John’s journey.”

Tippett Studio designed a full-body size scavenger still known as Constantine, a tanky, industrialized creature with layers of heat painting, reduced for effects on set. In the movie, artists created a full-scale silicone animatronic puppet with facial articulation and cable-operated finger movement. Camera operator (Mark LaBonge M arkLaB) lines up a shot of the animatronic scavenger demon as it spies on Constantine from the ruins of a car.

Constantine is stalked by a scavenger demon that spies him from a burnt-out car. For initial closeups of the creature, production shot the Stan Winston Studio animatronic, operated on set by six puppeteers. Subsequent shots of the demon climbing from the wreck and pursuing *Constantine* with four other demons were animated digitally. Tippett Studio built digital scavengers from a cyberscan of the Winston puppet and rigged the hero creature with muscle and skin simulations. “We tested scavengers with subsurface scattering,” said DeBry, “but it made them look too wholesome. Subsurface scattering comes from fatty layers beneath the skin, but these guys were pretty much skin and bones.” Final looks were achieved with detailed modeling and self-shadowing effects, rather than painted texture maps. “These demons were not supposed to be glistening, gooey creatures in the traditional horror movie fashion. These were grim.”

More creatures are revealed as the camera cranes down beneath the freeway where a teeming mass of people is being devoured. Mike Fink shot a motion control move on a greenscreen set, filming multiple passes with a group of extras repositioned in different areas of frame and intermingling fighting greenscreen stunt performers to build up the imagery in 25 layers. Tippett Studio tiled selected takes together and replaced stunt performers with animated demons.

Constantine escapes his attackers by taking a running leap from the top of a crashed car, grabbing at a hospital identity bracelet discarded by Dodson’s sister in Hell. Reeves performed the stunt wearing a wire harness, leaping 20 feet against greenscreen as cameras rolled at 96 frames per second. Tippett Studio enhanced the energy of the stunt with particle motion, lightning flashes and heat haze, and composited keyframe-animated scavengers leaping after *Constantine* as he shatters a bulb of holy water against his chest and transports himself back to earth.

The narrative unfolds with a series of mysterious, demon-inspired deaths, including that of *Constantine*’s clergyman advisor Hennessy (Pruitt Taylor Vince). As originally planned, the character was to eat himself to death in a cafeteria, paradoxically wasting away as he shoved food into his mouth, until he was nothing but skin hanging from a skeletal form. Stan Winston Studio lifecast Taylor Vince and two performers with progressively slighter builds and started sculptures that would wither Hennessy through the use of elaborate prosthetics and deflating bladders, designed to

work in conjunction with digital effects. “Pruitt’s face and hands were going to be CG,” stated Fink, “and the food was going to be CG as he shoved it in. It was going to take three days to shoot first unit and three days for second unit. It was a huge deal.”

When costs for the diner death proved prohibitive, the production relocated the scene to a liquor store where Hennessy desperately attempts to satisfy an unquenchable thirst. Lawrence filmed the scene from Hennessy’s point of view, with the character breaking open bottles and swilling the contents, finding them all empty — while in reality Hennessy drowned in alcohol. Cut together, the sequence proved confusing, and Lawrence revised his strategy. “Francis asked us to put liquid in all the empty bottles,” said Fink. “He didn’t want the liquid to pour as Hennessy tilted the bottle to his lips, but it had to pour out when he set the bottle down.” CIS matchmoved all the bottles, added and removed bottle caps, replaced entire bottles wherever labels obscured the contents, and added fluid dynamic simulations to create sloshing liquid effects with reflection and refraction. Postproduction camera moves, created by cropping into the Super 35 film frame, allowed CIS to reframe shots, lingering on bottles to emphasize the liquid inside. As Hennessy expires, CIS added a fluid simulation to enhance liquid bubbling from the actor’s mouth.



Investigating a rash of demon-inspired deaths, Constantine discovers his weapons purveyor, Beeman (Max Baker), smothered to death by flesh-eating flies. Stan Winston Studio created prosthetic sores to cover Baker's exposed face. Hydraulx then employed a cyberscan of the actor's face and tracked digitally generated flies to the scene. Fly animation utilized two fly models – a low-resolution version for flying, and a detailed version with articulated wings and legs for crawling. Hydraulx artists employed particle systems and keyframe animation to replicate the insects, and turbulence fields to propel the swarm.

Another gruesome death depicted later in the film involved Constantine’s weaponry purveyor, Beeman (Max Baker), who is smothered by flesh-eating flies. Stan Winston Studio created a prosthetic makeup to cover Baker’s exposed face with Prosaid sores. The physical effects team experimented with swarming insects simulations, using Cocoa Puffs and cork chips agitated by air inside an acrylic case, but the flies were ultimately created digitally by Hydraulx. “We used boujou to track flies to a cyberscan of the actor’s face,” explained Hydraulx visual effects co-supervisor Colin Strause. “It was half particle system, half brute-force keyframing a little low-rez fly, which had a very simple body, wings and a little transparency matte for the legs. The ones crawling on Beeman’s face were more complicated, with articulated wings, articulated legs, 3D motion blur, ambient occlusion, iridescence and subsurface scattering to give them a little extra glow, rendered in mental ray.” Animation supervisor Joshua Cordes used turbulence fields to propel the swarm as Constantine swipes flies away. *Inferno* artists then mixed in key-light and fill-light passes to composite the flies around a 3D version of Beeman’s head.

The murders lead Constantine to confront their perpetrator, the half-breed demon Balthazar (Gavin Rossdale). Constantine wields a holy shotgun — a cruciform metallic firearm constructed as a practical firing device — and lets rip, blasting open a mirror in Balthazar’s high-rise conference

room before obliterating the demon's face with a splash of holy water. ESC generated digital heat-blistering effects in the glass and rendered the mirror explosion through a combination of 2D flame elements and 3D glass particle effects. Stan Winston Studio created Balthazar's inner demon as a practical makeup effect, a twisted mass of greenish gristle and tendons beneath the character's camouflage of human flesh. "The initial reveal was always designed to be a CG effect done at ESC," explained Fink. "Then, from the first cut after the water impact, the eroded face was a prosthetic. You can cheat facial erosion pretty successfully by adding makeup to a face, but there are some things CG can do more effectively, and we were on that edge. In this scene, however, Balthazar had four pages of dialogue, which meant 60 or 100 shots featuring his face, and the budget couldn't handle that. So John and Shane designed a makeup, and we did some digital manipulation to help."



As Constantine closes in on the source of the demonic activity, his companion, police detective Angela Dodson (Rachel Weisz), is ripped from his protection and tugged out of a high-rise building by a powerful unseen force. Full-scale mechanical effects initiated the effect, which then shifted to a 1/3-scale miniature of an office set created by New Deal Studios. Careful attention was paid to set dressing prior to shooting the explosive effect.

The Balthazar makeup originated with conceptual designs by Aaron Sims, which Shane Mahan sculpted onto a clay replica of Rosssdale's face. Stan Winston Studio generated the Balthazar silicone prosthetic in two stages — initial skin contusions revealing pockets of demon flesh, and a more extensive makeup with overlapping teeth and a shriveled left eye. To simulate holy water impact, the physical effects team devised a water bomb. "Jack Jennings came up with the idea of using clear plastic that comes in a tube," said Allen Hall. "He devised a way to blow plastic bubbles full of water to make clear plastic eggs that looked like water just hanging there. We had to get somebody else to fire them because Jack is a terrible shot — but he has a lovely mind."

ESC generated Rosssdale's disintegration starting with scans of the Winston makeup. "Balthazar's initial demon skin reveal was a complete CG replacement of the blistering parts of his human face and demon skin," said George Murphy. "We created a complex, multi-layer reveal to a fully-CG render, with transitions based on the original Winston topologies. It took weeks to perfect." CIS took the deterioration through its later stages as Balthazar converses with *Constantine*, pinned to the conference table, half of his face exposed. "We enhanced the prosthetic in 2D," said CIS visual effects supervisor

Bryan Hirota. "We tracked smoke and little bits of flesh to the curves of Gavin's face, and then did animation using Shake's warping tools to make him talk and blink. We replaced his left eye and warped the lid to make it blink and move in time with the right eye."

Late in postproduction, the scene was expanded to reveal Balthazar shattered to pieces by a holy shotgun blast, the pieces continuing to converse with a half-seen shadowy figure. "We shot that scene eight months after we struck the set," recalled Fink, "so we just set a table in front of a greenscreen, and then CIS built the room and shattered pieces on the table in CG, using photographs and measurements of the set."

Stan Winston Studio provided CIS with designs of Balthazar in pieces and a maquette that had been used on set to frame shots. Motion Analysis Corporation recorded facial motion capture of Rosssdale delivering his lines, and CIS applied the data to its exploded model. "We modeled half of Gavin's eroded face as a hard-surface model," remarked Hirota, "then scored it and cracked it into pieces." CIS blended keyframe animation and motion capture, using shapes around the mouth to dial in phonemes and rigid-body dynamics for cracking. The scene concludes with Balthazar blown away in a cloud of ash, rendered in RenderMan using CIS volumetric particle technology.



New Deal painter Cathy Burns details a puppet of Weisz, which was rigged to a postand hauled backward through the set by motion control.

After the confrontation with Balthazar, a supernatural force rips Dodson from Constantine's side, propelling her backwards through metal elevator doors and several adjoining walls and rooms before blasting her out through an exploding window and into the night. Parts of the scene were realized on stage utilizing motion control and a powerful array of physical effects, such as breakaway sets and soft aluminum elevator doors ripped apart by hydraulic rams. For shots tracking through the sets, a motorized winch towed the camera along a track at 26 feet per second, rushing through an exploding cement wall, then through cinderblock into a lavatory rigged with breakaway mirrors and exploding toilets. To choreograph events, physical effects technicians developed mechanical rigs and implemented destruction effects using a bullet-hit machine synchronized to the motion control camera. "We put LEDs along the track and calibrated them so that they set off each event as the camera passed," noted Allen Hall. "We calibrated the rig in less than a day, and shot the whole thing in two days, even though they had scheduled two weeks. It worked very well."

Weisz was then filmed suspended against greenscreen, seated on a mobile sled for the initial tug from her standing position, and towed vertically with the camera looking up from below for subsequent angles. ESC composited the actress into the exploding set and added debris to enhance the effect of an invisible force wrapped around the woman. New Deal Studios continued the flight through a miniature of 25 office cubicles. "It didn't make sense to build a large full-sized set for one shot," said New Deal supervisor Ian Hunter. "Mike felt it made more sense to do it as a miniature, because the shots on either side were physical effects. We designed the miniature to use effects techniques similar to the full-scale set to help shots cut together."

New Deal crew chief Aaron Haye built the office miniature at 1/3 scale, resulting in a 25-foot-square expanse with a three-foot-high ceiling. For accessibility, the set was built in two halves, split lengthwise, which modelmakers could unbolt and roll apart. New Deal mechanical designer Robert Spurlock built a track beneath a slot in the center of the miniature, then mounted a servomotor-driven dolly to the track, with a small post extending through the set. Modelmakers fastened a 1/3-scale poseable puppet in the likeness of Rachel Weisz to the post. A motion control camera was mounted over the dolly track, linked to the puppet dolly by Kuper motion control. As the camera and puppet moved backward, the dolly triggered micro switches that detonated events before the puppet hit office furniture.



The archangel Gabriel (Tilda Swinton) appears to Constantine with muscular wings spread wide. Stan Winston Studio created a 1/4-scale feathered wing maquette for lighting reference. Complete with a mechanical armature, the maquette was patterned after the dark falcon-like wings of an angel in a classic Caravaggio painting. ESC generated the wings entirely digitally, using an intricate feather animation rig that translated gross wing motion to individual feather motion, with several dozen source feathers controlling a matrix of several thousand secondary plumes. The wings, animated to gently flap and fold, were then tracked to Swinton's performance.

Breakaway cubicles and desks were built over steel frames, hinged and prescored for pneumatic pistons to rip apart. Spring-loaded rat-trap devices were also targeted to flip office furniture into the air as the camera rushed through the set. "All the magazines in frames along the walls were fake publications with photographs of New Deal crew members," Hunter remarked. "To make the front cubicle look lived in, we added a picture of me painted by my dad when I was eight, and a picture of Bob Spurlock's son, both in 1/3 scale." Miniature director of photography Tim Angulo covered the shot in two takes, with the camera zipping back 25 feet in three-quarters of a second, shooting 72 frames per second. ESC added camera shake and pyrotechnic sparks that rained down from a lighting fixture. The reverse angle of Dodson exploding out through the office window featured Weisz composited into a full-scale window explosion, enhanced with ESC digital glass fragments.

Constantine rushes to the window as the camera drifts away from the building. Reeves performed the action in an office window set, filmed with a wire-flown Spydercam rig that retreated from the actor to the highest corner of the soundstage. ESC created an overlap matchmove that blended into the camera motion and continued the retreat for another two-thirds of the move. To generate the nighttime cityscape, Mike Fink shot locked-off motion picture tiles from rooftops of downtown Los Angeles buildings; ESC stitched together six plates and nested the Spydercam element into a CG foreground building. "We faked in CG windows either side of Keanu to help parallax with the foreground," said George Murphy. "We then created the rest of the windows, the building around him and the adjacent buildings with combinations of texture-mapping on the outside and digital interiors. Subtle effects like dust and smoke and tiny drifting office papers reinforced the sense of the explosion."

To investigate Angela's disappearance, *Constantine* initiates an out-of-body experience by submitting to a zap in an electric chair. Hydraulx depicted *Constantine*'s psychedelic mind trip in a swirling minute-and-a-half sequence that reveals the whereabouts of the *Spear of Destiny*. Hydraulx used a fluid simulation to create a swirling foggy nebula, filled with a maelstrom of Maya particle effects and 3D flying chunks, like debris inside a tornado. Images of *Constantine* spying on the *Spear of Destiny*'s journey to Los Angeles were blended into the fog in Discreet's *Inferno* through the use of shifting frame rates, blurring morphs, and tearing and shattering effects. "The workflow was unique," explained Hydraulx co-supervisor Greg Strause. "We had to composite all the blowing winds of Hell, comp those onto film plates with distortion effects, then export those from the *Inferno* back to 3D. The 3D guys then mapped images onto exploding surfaces, which went back into the *Inferno* for compositing into the background. It was a big feedback loop with no way of rendering all the elements and just finishing the shots in the *Inferno* — there was a constant back and forth, building up layer on layer."



Constantine and his youngprotégé, Chas ((Shia LaBeouf)), attempt to revive Dodson, who has been possessed by Mammon, son of Satan. Stan Winston Studio created prosthetic makeups for Rachel Weisz in her possessed state, which included a forehead piece without eyebrows, teeth,contact lenses and body makeup. Wide shots of Dodson in her inertstate also used a detailed siliconedummy, fabricated by Winston Studio from cyberscans andlifecasts of the actress, that was made for shots of her character's deceased twin earlier in the film. Tippet Studio digitally distended Weisz' abdomen for shots of thewrithing Mammon extruding through Dodson's torso.

Constantine and his young associate Chas (Shia LaBeouf) next arm themselves for a showdown with the half-breeds, forging golden bullets — a physical effect involving digitally colorized molten Cerablend, a soft metal used by magicians for spoon-bending gags. Facing a crowd of half-breeds guarding Angela in a hospital hydrotherapy room, the exorcists incapacitate the demons using holy water fed through the sprinkler system. Allen Hall's team rigged the set with a network of overhead water nozzles, allowing filmmakers to douse selected quadrants of the room. Stan Winston Studio collaborated with Ve Neill, key makeup artist Joel Harlow and a team of 15 other makeup artists to create prosthetic effects for the scene on close to 80 performers. ESC then applied smoke and generated demon dissolving effects, the majority of which were shot in practical rain. "We wanted to see water running down their faces and bodies," said Fink. "We felt that no matter how much eroding we did digitally, the areas of the body we retained would benefit by having water hitting them."

High angles looking down featured rain simulations — with practical sprinklers only on the perimeter of the image — leveraging ESC's experience with 3D rain on *Matrix Revolutions*. "The trick we learned on *Matrix*," said Greg Juby, "was that if you layer in your CG element and then put rain on top, it's not as hard to get it to line up as you think. But adding rain and ground water and 'ploinking' water impacts is a lot of work; so we re-created rain near the camera and rain hitting surfaces. What sold the effect was interactive lighting, matchmoved and animated so that the rain didn't look opaque or misty."

Amid the downpour, a musclebound demon (Tanoai Reed) leaps at *Constantine* and explodes in a combination of holy shotgun blast and dissolving water. Stan Winston Studio created the disintegration as a physical effect, designed by Shane Mahan and Christopher Swift, which intercut ESC digital disintegrations. Artists sculpted Reed's body from a cyberscan and cast a replica in a soda plaster mixture traditionally used for breakaway stone. Hollowed out, painted and filled with a skeleton, internal organs and ten gallons of black goo, the dummy was raised 13 feet above the studio floor and then released to crash onto a sheet of mirrorplex with greenscreen backing. ESC lined up the explosion with a plate of the performer's jump, added digital rain and 3D goop to blend the impact with the floor and background, then furnished additional demon facial erosions, skin peels, head and limb removals and morphing techniques to warp demon carcasses, turning half-breeds to mush.

The movie's climax plays out inside the hydrotherapy room, with Dodson now possessed by Mammon, son of Satan, source of all the evil incarnations. Stan Winston Studio created prosthetic makeups for Weisz in her possessed state, which included a forehead piece without eyebrows,



As Constantine battles to save Dodson's life and soul, a greater force intervenes and rescues the exorcist from eternal damnation by elevating him to an ethereal vista of glowing clouds and soaring architecture designed to suggest a parallel reality of Los Angeles as Heaven. Hatch Production developed concepts for heavenly vistas over a span of seven months. The final shot included footage of Keanu Reeves composited into a digital matte painting constructed by blending and manipulating elements of liquid nitrogen shot at high camera speeds, photographic elements of Los Angeles towers and cloud footage.

demon teeth, black shark-eye contact lenses and veined, pallid body makeup. Allen Hall's team supplied mechanical rigs to raise Weisz explosively from the hydrotherapy pool. Tippet Studio digitally manipulated Weisz's abdomen for shots of a demon form writhing and extruding through Dodson's torso.

Sensing that another supernatural force is responsible for Mammon's presence, *Constantine* uses a ritual incantation to summon the androgynous half-breed angel Gabriel (Tilda Swinton). Hydraulx generated the effect — known as the 'light command' — warping and darkening the room to reveal the volumetric shape of Gabriel's angel wings. "We used a lidar scan of the set to build a 3D shadow world," related Colin Strause. "We darkened the room and added shadows that move up the walls and across the ceiling, then form a smoky, volumetric silhouette. We did all the interactive lighting in post. We roto'ed Keanu and the environment and used lidar data to generate mattes separated in perspective." ESC supplied a 3D angel wing rig, which Hydraulx used to generate fluid textures and emit particle effects that formed into the wing shape. "We rendered different passes at different offsets to create a lens distortion effect. Francis wanted it to have substance and thickness, although it was not a solid object. It was a really tricky balance. We did about 70 versions of that shot."

Once manifest, Gabriel converses with *Constantine*, angel wings filling the room with a muscular feathered span that gently flaps and folds. Winston Studio built 1/4-scale wings — an articulated armature dressed with peacock, turkey and Canada goose feathers, painted in dark, falcon-like colors reminiscent of an angelic character in a Caravaggio painting. ESC used the wings for lighting reference on set, then designed a fully digital version with an intricate feather animation rig. Digital artist Allan Andrique developed controls to translate gross wing movement to individual feather motion, several dozen source feathers controlling a matrix of several thousand secondary plumes. Feathers were divided into offset layers on the reverse of the wing, allowing plumage to fill gaps, maintaining a thick and stately feel. The technical accomplishment was greatly assisted by Tilda Swinton's performance, which informed animation of the enormous appendages protruding from her back. "Our main wing animator, Jeremy Bolan, had a blast working with Tilda's performance," said Greg Juby. "She really behaved like she had those wings on her."

Gabriel reveals a scheme to bring about an apocalyptic reckoning by using the *Spear of Destiny* to pierce Dodson's body and release Mammon. Though Mammon had always been planned as a Tippet Studio animation effect, Winston Studio first created the character as an articulated puppet based on an Aaron Sims conceptual design. "Francis wanted Mammon to feel distinctly different from the half-breed makeup designs," John Rosengrant said. "Our first designs were very creepy, but Francis felt they were too much in the realm of *The Lord of the Rings*. After that, we arrived at the idea of Mammon being more like an adolescent boy." Winston Studio concept artist Joey Orosco sculpted a full-size, five-foot-ten-inch Mammon maquette that was cast in silicone and fitted with a smile mechanism and a mechanical rod puppet armature.

Originally, the scene was designed to show Mammon in a head-and-shoulders closeup. "There was going to be just the briefest moment where Mammon appeared before he inhabited Angela," related Mike Fink. "As Gabriel was about to free him, we were then going to see Mammon's face pushing through Rachel's skin. But when we cut the movie together, it wasn't clear who this guy was inside

Angela. That brief appearance was not enough to establish his identity. This was one of those moments where the original concept of a dark and not-too-clearly-seen effect gave way to a more developed creature reveal.”

The retooled scene required a more lingering introduction, with Mammon descending steps, approaching Angela in a Hell vision of the hydrotherapy room. Tippet Studio used cyberscans and photographs of the Mammon puppet to create a 3D model for the scene. “We already had Hell working,” said Craig Hayes, “so it was no problem to open up hydrotherapy Hell. We just added scavengers around the pool to create more threat. The real issue was how to make it clear — in two shots — that Mammon was going to possess Angela.” Tippet Studio generated previsualizations, using imagery of Weisz in hydrotherapy Hell and a greenscreen shot over the actress’ shoulder, then keyframed the demon’s approach. “We wanted to show this guy really seething as he approached. We ended up taking cues from a young Iggy Pop — we made him very skinny and muscular and animated the amplitude of his muscles and his veins; so as he walked, there was a subtle pulsing and he became more grossly muscular.” Muscles and veins were modeled in 3D and animated with muscle and skin simulations, then accentuated with paint effects and displacements.

Constantine halts Mammon’s appearance by summoning the creature’s father, Satan (Peter Stormare), whose presence brings about a time-dilation effect. As Satan makes his way to the hydrotherapy room, glass doors shatter, causing a shower of glass fragments to float in midair. ESC generated glass chunks using particle simulation and glass shaders, animated with procedural dynamics and keyframe foreground interaction. The time suspension ends as Satan pulls Mammon from Dodson’s body. Tippet Studio generated four versions of the scene. The selected version featured a postproduction camera move tilting down to reveal Mammon reflected in the tiled floor, in hydrotherapy Hell, struggling in Satan’s arms. Tippet Studio then animated the demon falling into the sky as if he had been cast away.

The scene concludes with Satan blasting Gabriel backward into the hydrotherapy pool, a shot generated by ESC using exploding water elements filmed by Mike Fink in *Fantasy II*’s large-scale water tank. “That was 90 percent layered live-action water, with ten percent CG sweetening,” remarked George Murphy. “We really beat it with brute force in the composite, layering the elements.” To show Gabriel’s wings being incinerated in Satan’s blast, ESC employed a shader-driven erosion texture that animated fire across the feathers, first obliterating fine hairs and then the center barbs. Furious FX collaborated on the scene, generating additional particle-emitter ember effects.

Satan returns to *Constantine* to claim the exorcist’s soul, but a greater force intervenes, pressing *Constantine* into the hospital floor and cracking tiles as Satan drags him backward by one hand. Reeves and Stormare performed the scene without interactive cracking effects. CIS rotoscoped the actors from the shot and generated a matchmove in a 3D re-creation of the set. “We took Keanu off the real floor,” said Bryan Hirota, “put in a fake floor, then put Keanu back with cracking and shadows.”

The camera then drops from a high angle of Reeves to a view below the floor, looking up to reveal *Constantine* elevated against a vista of clouds and soaring architecture — the parallel reality of Los Angeles in Heaven. Mike Fink shot the transition with the camera first dropping down past Reeves,

passing through a cavity in an elevated set, then repeated the move booming down to the solid floor. Hatch Production blended elements, faking the horizon line and applying interactive lighting effects to tie into the heavenly vista beyond.

Hatch visual effects supervisor Deak Ferrand developed Heaven concepts over a period of seven months, with influences ranging from Hawaiian landscapes to space shuttle booster rocket clouds. The final composite included liquid nitrogen elements shot at Fantasy II at 120 frames per second, then time-stretched to even slower speeds and blended into photographic elements of L.A. towers and glowing cumulonimbus clouds. Composited with soft-edged mattes blooming against the vista and a Digital Anarchy lens flare, *Constantine* gives a one-fingered salute, provoking Satan to pull him back to earth. Satan then tears cancerous tumors from *Constantine*'s lungs — a Winston Studio prosthetic effect, combined with a CIS composite — ensuring that the exorcist will live to fight another day.

Grittier than most comic book adaptations and more ambitious in its concepts, *Constantine* redefined genre categories. "This was not a horror film," noted Mike Fink. "It was more a creepy thriller, disturbing in places, but not a traditional Hollywood movie. We wanted to present horror imagery in a non-traditional way. There was never an attempt to tap into classical archetypes. What Francis was trying to do, and I think he achieved, was to make the movie feel like this was really happening, right here in L.A. He set a tone that made all the fantastic elements live together. We created a world where you could accept these things as real."

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Q&A George Lucas

ARTICLE BY JODY DUNCAN

Driving my teenage daughter to school the other day, I asked if she might find a ride home with a friend that afternoon. “Sure,” she said. “Why?” “Because I have a 4 o’clock interview with George Lucas.”

She laughed at me. “Mom, you say that so casually — because, like, you know, doesn’t every Mom have to arrange her schedule from time to time to fit in an interview with George Lucas?”

I may have sounded casual about the prospect of talking with Lucas, but I didn’t feel that way. The planned interview was, in fact, something of a momentous occasion. Though we would discuss a range of subjects, the catalyst for the interview and its primary focus was the imminent release of *Revenge of the Sith* — an event of worldwide interest, as it represented the final chapter in a moviemaking saga that began nearly 30 years ago.

On a more personal level, the upcoming interview was significant because, most likely, it would be the last time I would talk to Lucas about a *Star Wars* movie. The films — particularly those in the current trilogy — were near to my heart, as I had either co-written or single-handedly written ‘making of’ books for two of the three. I had also written very long articles on all three films for this publication. Between the books and the articles, I calculated that I had produced some 125,000 words on the subjects of Episodes I, II and III over the past seven years. I’d been eating, breathing and dreaming *Star Wars* for a very long time; but, with this conversation, that subject would be forever behind me.

Finally, the prospective interview with George Lucas was significant because, well É it was an interview with George Lucas, an authentic, honest-to-goodness icon of the film industry.

Despite being on the ‘most wanted’ list of every major publication as excitement over *Revenge of the Sith* grew, Lucas was good enough to spend nearly an hour talking to me about the filmmaking odyssey that has been *Star Wars*, and about his vision for the future É

You’ve said in the past that you began your *Star Wars* saga in the middle because the technology wasn’t in place in 1977 to do justice to the first part of the story. What kinds of technological advancements did you imagine would have to develop to make filming the first part of the story possible?

It wasn’t that the technology wasn’t there. That was just the way I wanted to tell the story, starting in the middle. I don’t like to tell stories from the beginning! No, what I said was that *Star Wars* was meant to be one film — it was just going to be Episode IV. But as I wrote it, it grew to be bigger than what I expected, so I ended up doing three movies instead of one. I’d also written the backstory. But when I finished the three movies, I figured that would be the end of it. The backstory I’d written was



basically just for exposition and information; and I couldn't figure out ways to shoot it anyway. It wasn't something that could be easily filmed. So I said: 'I've done the three movies. It's finished.' It wasn't until new technology came along and I decided to start directing again that I thought about the possibility of telling that backstory. After *Jurassic Park*, I realized that I could do things like have Yoda fight. I could have digital characters that could act, and I wouldn't have to deal with rubber masks anymore. I also realized that I could go to Coruscant on a large scale, that I could go to environments that weren't possible before. It opened up a whole new world for me. I could do things without being stifled all the time, without hitting that technological ceiling that one gets into when one is doing science fiction.

So it wasn't a matter of your sitting around waiting for that technology to come along; it's just that, once the technology revealed itself, you realized you could make the other three movies.

Yeah, it was that — and other things. I'd basically retired in order to raise my children. But my children had gotten old enough that I could go back to work again. The technology was there to do the backstory. And with the reissue of the *Star Wars* special edition, which was hugely successful, I thought, 'Hey, there's still a market for this kind of stuff.' My thought was that if I didn't do it now, I'd never do it, because I was 50 at the time and it was a 10-year project. I figured that if I went off and did other movies for a while, I'd probably never get back to it. So I had to make the decision at that time, and I decided to do *Star Wars*.

As you look back over the process of making these last three *Star Wars* movies, how has the journey been different than what you thought it would be?

Well, we had a lot of technological hurdles to overcome with these movies — the switch to digital, all of the animated characters — but everybody was up for the challenge. It was fun, more than anything else.

You initially faced those technical hurdles for *Phantom Menace*. Did the technology improve between that film and this last one as much as you had hoped it would?

I don't really have hopes in that area. It's never improving as fast as I would like, and I'm always pushing the envelope. But it improved considerably between the three movies. I had a lot of frustrations on the first film; but we were light years ahead when we got to the second film. On the first film, we had these beta test digital cameras, and we couldn't move things around, and we could only do it when we were shooting the second unit stuff — the post unit. But when we got to the second film, I had the cameras, I had the lenses, and we were actually shooting the whole thing digitally. We'd also made advancements in animation. When we'd done Jar Jar and some of the early animated characters, just building them and making them move and animating their faces was very hard and labor-intensive. It was like mowing a lawn with an old push-mower. But by the time we got to *Revenge of the Sith*, a lot of those problems had been solved. It was much easier and faster for people to do their jobs, all around, because the machines were doing the heavy lifting.



In Tunisia for Attack of the Clones, writer/director George Lucas poses with one of the Sony high-definition digital video cameras with which he shot the film. Lucas followed up that groundbreaking use of digital technology during production of Revenge of the Sith, employing the much-improved, newest-generation HD cameras to capture his images. One of the earliest proponents of HD, as a medium for projection as well as capture, Lucas is encouraged by the acceptance of the new format in Europe – where hundreds of theaters have switched to digital projection – but laments stubborn resistance to the technology in the United States.

With *Revenge of the Sith*, you are closing the loop between this trilogy and the first one, bringing the story full circle, and introducing the ship and hardware designs that were in the first *Star Wars*. How have your tastes and your aesthetic sense changed in the past 30 years? For *Revenge of the Sith*, were there any designs you wish you weren't locked into because of the first movie?

Well, because I look at all the films as one piece, I worked very hard to keep the style the same, keep the style of acting the same, and to make them all as similar as possible so that they would play as one piece. So I never questioned the designs. Obviously, I've looked at some of the old designs and thought, 'I could do a better job on that now.' But it's like



On the set at Fox Studios Australia, Lucas directs Hayden Christensen in his role as Anakin Skywalker in Revenge of the Sith. Though production designer Gavin Bocquet designed and constructed some full sets for the movie, Lucas expanded upon an approach he had implemented in Episodes I and II, shooting his actors against bluescreen

looking at a Model T Ford — that's what it was, for better or worse. I never really worried about that.

So you never felt hamstrung by those original designs.

and surrounding them with 2D and 3D settings realized by Industrial Light & Magic. The ability to create fantastic settings digitally was among the factors that spurred Lucas to finally deliver the long-awaited three-film backstory to his original Star Wars trilogy.

No. The whole nature of that project was very narrow in scope. The costumes were narrow, the design was narrow, where they traveled to was very narrow. There wasn't much to it, primarily because, technologically, I couldn't do it. The ships were designed so that they could be built out of plywood, for example. We couldn't do curves because they cost too much money. There were a lot of design elements that were determined because that was the way we had to do it back then. But I didn't have to deal with any of those things when I got to doing the second project digitally. I was free to design a ship any way I wanted, and it wouldn't cost any more. I was free to go to a lot of different places around the universe, which meant there were going to be a lot of different cultures, cities, costumes. *Instead* of being narrow in scope, it was expansive. So the second project was a very different kind of design challenge than the first.

In an interview you did with us almost ten years ago, when you were working on the special editions of the first trilogy, you said you wanted to do them because you'd been frustrated and compromised by the limitations of the technology of the day. You thought you'd only managed to get 60-70 percent of what you wanted, especially in the first film. What kind of percentage would you put to Episodes I-III? Do you foresee ever feeling that same level of frustration about these later films?

No, no. I'm very happy with the way the last three have turned out. I pretty much got everything I wanted. I'd say they are 96 percent of what I wanted. Even on the first films, I went back and fixed what I didn't like — that was the whole point of the special editions — so now I'm happy with those films, too. I'm not at all frustrated the way I was before. People look at the special editions and say, 'Well, there's not that much difference — they're the same movies, except maybe the Jabba the Hutt scene added in there.' But those little changes made a very big difference to me. Those things had bothered me a lot. A lot of the shots that didn't get in there originally because of time and money, finally got in there.

Your current *Star Wars* films pioneered the extensive use of greenscreen/bluescreen stage work combined with synthetic environments — and we've seen it in movies such as *Sky Captain* and *Sin City*, as well. Where do you see this technology going? Do you see it being used in mainstream filmmaking?

I think it already has been. When we did Episode I this way, everybody said, 'Well, this is great for science fiction films, but it's not going to affect any other kinds of films.' But look how the industry has changed, just since then. At that time, the kinds of movies that you were allowed to make were very restricted. They were usually small and contemporary. The idea of doing an epic film had disappeared over the years, because nobody could afford the extras, the sets. So the industry was forced into a very limited kind of movie. If you wanted to do a historical piece, the studio would say, 'Well, the market isn't there for it' — which really meant that the market wasn't there for the price it was going to cost to make it. After Episode I, I said: 'You know, now you can do period pieces

again. Many genres of filmmaking have been lost, but now they'll be back. You'll be able to see films from all periods of history, and you'll have epics and battles and all kinds of things that we've lost.' And that's what happened. This technology isn't really about science fiction movies, anyway. We're just on the leading edge, pushing the envelope of the art form.

You were a lone voice in the wilderness when you first starting pushing the industry toward digital filmmaking. Now, with filmmakers such as Robert Rodriguez and James Cameron committed to the idea, do you think momentum is finally gaining?

Nope. We had a digital conference three years ago, with all the people who had worked in digital cinema: Jim Cameron, Robert Rodriguez, Michael Mann, myself and the Pixar guys. That was it. That was all the people who'd had any experience with it. We invited a bunch of our friends to come, as well, so there were maybe 25 to 30 people there. The five of us who had worked in digital cinema got up and explained what it was all about, what the problems were, what the tricks were. Now, three years later, we're about to have another conference; but the only new person joining us is Bob Zemeckis. So, we've gone from five people to six people in three years! Out of the 6,000 people making movies, there are six of us actually doing it digitally. And the theaters — when I did Phantom Menace, I was in four digital theaters. We pioneered that. Then, the next film we got into about 120 digital theaters. But for this one, we're back down to about 80. A lot of the theaters sold their projectors, because nobody was making films for them. We're getting a lot more success outside the country, though. We're up to about 300 theaters outside the country; so we're putting our hopes on the rest of the world, rather than on the United States.

What's the problem here?

Well, the film industry has sort of conspired to keep it out, to keep it from happening.

Why?

They don't like change.

Is the resistance coming from directors, or more from the business side?

It's the cameramen, the studio executives, and some directors. A lot of the directors are convinced, but when they try to get the studio and the cameramen behind them, what they hear is, 'Oh no, don't do it, it's not there yet.' People make up all kinds of fictitious stories about it. They say that the quality isn't as good as film, when in reality it's better. They say you can't store it — which you can, and it's better than film. Most of the things they say about it are not true at all.



Lucas directs C-3PO performer Anthony Daniels in a spacecraft hallway — familiar to fans as the setting for the opening scene in Star Wars — as droid technician Justin Dix and longtime droid supervisor Don Bies prepare to operate R2-D2. Lucas and his art department at Skywalker Ranch introduced a number of familiar Star Wars designs in *Revenge of the Sith*, as a means of tying Episode III — the final film in the current trilogy — to the original Star Wars, since redesignated Episode IV: *A New Hope*.

Do you see this resistance weakening any time in the near future?

It will eventually. How long can they hold out? Everything else is digital. This is the only major industry still using 19th-century technology. *Independent* filmmakers are using digital, of course; it's the studios who won't have anything to do with it. That's just the way they are.

You recently announced plans to convert all of your *Star Wars* films to 3D, using a 'dimensionalizing' system developed by In-Three. Why are you committed to doing this?

We did that to see if we could force the theaters into doing digital projection — because it won't work unless they have digital projectors. So it was a big push for that. And some of the people in our digital group — Jim Cameron and Robert Rodriguez — really like 3D and want to do it. We've converted part of *Star Wars* to 3D, and it looks fantastic. So I'm really high on the process. I've seen a lot of 3D, but I've never seen any that looks as good as this. But whether or not it goes depends entirely on the theater owners.

What does the dimensionalizing process entail, in lay terms?

Basically, you put the image on a computer and then you break it apart. You take the separate layers — foreground, middle ground, background — and you adjust them so that the parallax is right in 3D. You create two images that are slightly offset. And instead of being like it is in cinema, where you have blue-eye and red-eye and they store one image over the other image, with this they run images twice as fast, so the two images run one right after the other, and it comes out as a perfect 3D image. You don't get headaches from it. Your eyes don't get tired. It used to be that there were '3D movies,' which meant they were bad movies in 3D as an effect. Now, you'll be able to see films like *Star Wars* and *Titanic* in 3D.

So you still shoot the movie the same way. The 3D all happens after the fact, in the computer?

You can shoot it in 3D or you can have it done after the fact. And the way they look is equally good. There's been a lot of discussion lately about the 'new wave of 3D' — but it still seems to fall apart at the exhibitor level. In a controlled environment and with the right kind of glasses — like the *Imax* 3D version of *Polar Express* — it looks great. But in a multiplex situation it still looks pretty bad.



*Suited up as Darth Vader for one of the film's final moments, Hayden Christensen receives instruction from Lucas on the *Revenge of the Sith* set. Though several inches shorter, and slighter of build, than original Vader performer David Prowse, Christensen was determined to portray his character's evil alter ego himself, and convinced Lucas to let him don the Vader costume with risers in his boots to add height. New Vader helmets and masks were fashioned by ILM from molds of the original ones made for *Star Wars*.*

That's only if they use the old way of doing it.

So, assuming this new 3D makes it a good experience for the moviegoer, do you think all movies are going to be 3D someday?

I don't know. It's interesting to see a movie that's not specifically designed for 3D in 3D, because there is no one going out of their way to make an effect out of it. It's basically just watching a movie in a more realistic environment because you can see depth in it. So I'm not sure if that's going to happen, if people are going to accept it. I do know that for action films — like *Star Wars* and *Indiana Jones* — 3D is fantastic. And *Polar Express* was much more spectacular in 3D than it was in 2D. But for ordinary movies, I don't know.

Speaking of *Indiana Jones* — care to give us an update on the fourth one?

I just got a first draft of a script this week, and we're going to start work on the second draft. That process takes a while. But it's coming along.

You mentioned that this new 3D process is great for an action film like that. Is the next *Indiana Jones* going to be shot 3D?

Well, I'm still trying to get Steven to shoot digitally!

The last big holdout.

Yeah, I mean, he still cuts on Moviolas! He's of a different age.

You've been on the forefront of the last two big leaps in visual effects — motion control and digital. In general, is there anything you perceive as the next big thing in visual effects? Or is digital just going to get better and better for the next 50 years?

Yeah, I think digital is just going to get better and faster and easier to use. It is amazing what we can do, even now, with animation and building sets. Digital is truly like going from silent to sound or black-and-white to color. It is a huge leap in the medium itself. And it will just improve.

ILM is moving into its fourth decade. Ten years ago, you said that you thought ILM was about three to five years ahead of the competition when it came to technology. Do you still think that is the case?

Other companies are closer now, because people have invested a lot of time and money into the technology. But in some areas of software development, in speed of use of certain techniques, I think we're still ahead. We've got proprietary software that is a significant improvement over what other people are using.



*Lucas confers with producer Rick McCallum between takes on the set of *Revenge of the Sith*. As producer for the *Young Indiana Jones* television series, the *Star Wars* special editions, and Episodes I, II and III, McCallum has worked closely with Lucas for more than a decade. The producer and director plan to continue their successful collaboration as Lucas moves on to smaller film projects now that the *Star Wars* series has been completed.*

There's been speculation that the really large effects companies — not just ILM, but all of them — are becoming somewhat unwieldy and untenable, and will ultimately give way to leaner and meaner boutique-type companies. What is your take on how ILM and other big visual effects companies will evolve in the next decade or two?

It's hard to project a decade or two. I think there will always be a place for a larger company like ILM, because a company like that can do things that a smaller company can't, just because it has more resources available. ILM can spend a lot more time on research and development than a smaller company can. I don't think that is ever going to change. The boutiques work great, but they require that the studio or the producer build an entire infrastructure to manage multiple boutiques. I think people are beginning to discover that it actually costs them more money to do that than if they just took it to one place and got it done. At this point, the economics of it haven't quite sunk in.

Because the added cost doesn't really show up on the original visual effects budget —

— but it shows up later on, yeah. At ILM, we get a lot of 911 calls from people who have gotten over their heads. They get about halfway through a project, and then we have to come in and finish it for them. Every time that happens, somebody at the studio learns that trying to cut costs by using smaller companies doesn't really pay off in the end.

So how do you account for the recent rise of the boutique effects shop?

One reason for it is that there are a lot of effects producers who have an interest in spreading the work around because it gives them a job. Whereas, if you take the work to one bigger place, everything is managed in-house, so you don't need all that management staff. Eventually, a lot of the work that these smaller places are doing is going to get done in the editing room, anyway. All of the basic compositing, all of the wire removal, all of the touch-up things are going to be part of the editorial process. So all of that work is going to disappear. The big effects houses are going to be more focused on animation and very complicated effects shots that involve a lot of computer power and a lot of experienced talent.

As ILM prepares to move to the Presidio, is there a shift happening in terms of how the company is organized?

Yes, we are going through a kind of methodology shift. Lucasarts and ILM are going to be right next to each other, using the same servers and a lot of other things. We're encouraging the work concepts to drift between the two companies now, much more than we ever did before. The game company

"Yoda George"
Illustration by Mark Raats
www.markraats.com



"Yoda George" Illustration by Mark Raats
www.markraats.co

has expertise in some things, and ILM has expertise in other things; and I think letting them share their ideas and technology is going to help a lot in changing and improving the way they both work. I think it will advance the methodologies that they're both using.

I usually avoid asking sentimental questions, but I can't resist asking you about your feelings as you complete the *Star Wars* saga. Is there some relief that the burden has been lifted at last?

Well, yeah, there's a lot of relief for me. When you do a project that goes on for 10 years, you're always worried that something's going to happen to screw it up. But I made it to the end and nothing bad has happened. I'm happy and the films have turned out the way I wanted. So there is a great deal of relief that I actually got it finished at all. And I'll probably work with a lot of these people again — so it's not as if it is completely over. We're working on the animated TV series, and we'll probably do a spin-off live-action TV series, as well. So the *Star Wars* world will continue — I just won't be that involved in it. *Instead*, I'll get to go off and do some other kinds of movies, which I'm really interested in. I'm going to spread my wings and do things that aren't quite as restrictive as these movies have been. I'm looking forward to that.

Toward a New Hope

image

ARTICLE BY JODY DUNCAN

An old saw of the film industry is that making a movie does not teach you how to make the next one — it merely prepares you to make that particular movie all over again. Each new project is a start-from-scratch ordeal, during which filmmakers must confront and solve problems that are pertinent only to that current production and not to any that preceded it.

To some extent, *Revenge of the Sith*, the last of six *Star Wars* films and the final entry in the current trilogy, is an exception to that rule. Certainly, creator George Lucas, who had grappled with the expansive *Star Wars* saga and its fruition on screen for nearly 30 years, had learned a thing or two about making these films. Even those key crew members who had only entered the *Star Wars* galaxy with *Star Wars* Episode I: The Phantom Menace — appropriately awed and intimidated by its unprecedented scale — felt a hard-earned sense of confidence by the time the third episode went into production. Staffed with virtually all the same people who had labored on Episodes I and II, the production of *Revenge of the Sith* ran like a well-oiled astromech droid.

Among the processes Lucas had established in the previous productions and continued with *Revenge of the Sith* was a months-long conceptualization period in which the art department at *Skywalker Ranch*, supervised by Ryan Church and Erik Tiemens, produced hundreds of pieces of drawn and sculpted artwork, inspiring Lucas as he wrote the screenplay. In designing the movie's many alien planets, creatures, spaceships, droids, weaponry and other hardware, the Ranch artists 'closed the loop' between Episodes III and IV. In both design and narrative, *Revenge of the Sith* was a final, definitive move toward A New Hope.

"One of the most fun things about this show was linking the first trilogy to this one," said animation director Rob Coleman, "introducing designs that make more of an appearance in A New Hope." The cruiser flown by Bail Organa, for example, is a predecessor to the rebel blockade runner featured in the first shot of the original *Star Wars*. "It looks a little bit different, but you can tell it comes from the same factory. The design team at the Ranch did a great job of joining Episode III to Episode IV. Stylistically, we've



Ever since *Star Wars* exploded onto movie screens in 1977, fans have clamored for a film that would tell the backstory of how Jedi knight Anakin Skywalker succumbed to the dark side and transformed into the evil Darth Vader. In *Revenge of the Sith* — the final installment of the current *Star Wars* trilogy — writer/director George Lucas delivered that long-awaited tale in epic style. Under the leadership of visual effects supervisors John Knoll and Roger Guyett, artists at Industrial Light & Magic created exotic locales, fanciful characters and dynamic large-scale battles for the film, utilizing technologies that were still the stuff of science fiction when the original *Star Wars* debuted.



gone from that world of smooth chrome ships we saw in Episode I to the grittier look of *Star Wars*.”

Revenge of the Sith — again, like its predecessors — was also developed through extensive previsualization, providing Lucas with guidance in shooting his live-action and giving effects crews at Industrial Light & Magic a launching-off point for creating their final shots. “One of the things George and I had learned in doing the two previous films,” commented producer Rick McCallum, “was how important the animatics were to the final product. So we put a lot of time into doing animatics. We had an animatics group that went from about five people up to as big as 12 people, working for 18 months to produce 6,000 animatics shots. We’d done all the homework with the animatics, so by the time we gave them over to ILM, there was no misunderstanding about what the shot was. ‘This shot is 2.2 seconds long; we need six to eight frame handles on each side of it.’ That made a huge difference. It kept us from having to see 20, 30, 60 takes of the same shot at ILM as all the problems were worked out. It was all worked out up front.”

*An eight-minute-long space battle opens *Revenge of the Sith*, as Anakin (Hayden Christensen) and Obi-Wan Kenobi (Ewan McGregor) attempt to infiltrate a Trade Federation cruiser on which Chancellor Palpatine is being held captive. ILM spent more than a year building digital ships, droids and weaponry for the sequence. Compositors added practical fire and smoke elements to the shots. Such atmospheric effects were justified by the battle’s setting in the skies above Coruscant rather than in the vacuum of deep space — a first in the *Star Wars* series. Digital matte artists rendered views of the planet below.*

Visual effects supervisor John Knoll was among the trilogy veterans on set at Fox Studios Australia in Sydney and, the following year, at Elstree and Shepperton Studios in London. “The shoot for this show was remarkably similar to the shoot for Episode II,” Knoll said, “in that we were shooting in the same studio, with the same crew. Very quickly, we fell right back into the work rhythms we’d established in the last show.” The approach to the material was virtually the same, as well: filming high-definition live-action against bluescreen, on minimal sets, then fleshing out scenes at ILM with digital characters and miniature, 2D or 3D environments. The greater sophistication of Sony’s newest-generation 950 HD cameras benefited the process considerably. “The 950s were brilliant,” said McCallum. “Also, by this time, we were on our fourth generation of digital lenses. I think there have been more advances in lens technology just since Episode II than there had been in the twenty years previously. You really have to see the footage to believe it.”

“The new cameras are better in every way,” Knoll concurred. “They record RGB, and there is less compression. They have a better signal-to-noise ratio. They record at 12-bit instead of 8-bit per channel. In every respect, we were getting a better image — sharper, with better color resolution. That made extractions from the bluescreen much easier than the last generation of HD. It was comparable to film.”

A monumental task still awaited Knoll, visual effects supervisor Roger Guyett, visual effects producer Denise Ream, and the entire visual effects crew as the project moved into official postproduction. Over the course of two years, ILM would create 375 computer generated models and hundreds of 3D and 2D environments, construct and shoot 47 practical miniature setups, complete nearly 13,000,000 renders and composites, and deliver 375,000 frames, for a total of 2,151 effects shots.

The staggering numbers were made possible by a streamlined pipeline ILM initiated with *Revenge of the Sith*. One of the efficiency measures was the creation of a 15-person layout department, charged

with bridging the gap between the Ranch animatics — rendered quickly due to the accelerated pace of the preproduction schedule — and ILM’s final shots. “Everything we did was built off the building blocks that the layout crew set up for us,” explained digital matte supervisor Jonathan Harb. “They were the essential step between what the animatics team had done and what we really needed in order to do the final shots. The animatics guys are really under the gun when they’re working, and they have to do whatever it takes to get a shot in front of George, get an approval, and move on. But, as a result, for a shot of, say, a ship flying over some ground, we’d often get animatics in which the ship was actually sitting still and the ground had been animated! Or the ship would be the wrong scale in relation to the ground. This time, because of layout, all of those things had been worked out by the time shots came to us.”

Layout started each sequence by converting the animatics files into ILM’s pipeline. “We would replace their temp environments and other things with the final renderable versions,” said layout supervisor Brian Cantwell, “and get everything set up to our specs. We would also incorporate the bluescreen elements from production, as well as final matchmoves. Once we had everything put together, we would pass shots on to the various teams. The animators could take it from there, or we could send shots directly to the TDs for rendering, or to digimatte, or directly to the compositors. In Episodes I and II, those departments got to the same point in the end; but for Episode III we tried to centralize all of that work, to make the layout department the official branching-out point. Episode III was the test case for the pipeline of the future, an experiment in a new way of doing things.”

Layout was particularly beneficial to the animation team, which would produce a full 90 minutes of animation for *Revenge of the Sith*. “Because of the work done by the layout group,” observed Rob Coleman, “there was very little back-and-forth, trial-and-error stuff between us and the animatics guys compared to what we’d had to do on Episodes I and II. This time, we started off with something that was much cleaner. We animated 1,269 shots for *Revenge of the Sith*, and we probably saved a day to two days per shot because of the work by the layout group.”

Precious rendering time was also conserved, since the early layout of all the camera work pinpointed, in advance, where detail was needed and where it was not. In the past, not knowing where the camera might ultimately be positioned, effects teams would often fully render an entire CG environment for a scene. This time, layout’s early determination of the angles and proximity in which that CG environment would be viewed allowed effects artists to concentrate their efforts accordingly. “What it meant,” explained look development supervisor Kevin Reuter, “was that we did not have to spend a lot of time developing every detail of every environment. We could just throw rough textures and material on stuff we weren’t going to see that well, and then concentrate on the areas that needed a higher level of realism.”



In the course of the space battle, swarms of gremlin-like ‘buzz droids’ explode from missiles and proceed to manually dismantle Obi-Wan’s starfighter. An animatics team at Skywalker Ranch previsualized the overall space battle, then handed off its files to ILM, where animators—led by animation director Rob Coleman—choreographed heroshots of droids and ships in action. Technical directors employed newprocedural tools to generate laserfire and determine basic flightpaths for background ships.

ILM also revised its traditional pipeline by creating a digital environments group — headed by CG supervisor Hilmar Koch — which merged the virtual set work that, in the past, had been divided rigidly between CG and digital matte teams. “Now,” observed Jonathan Harb, “the matte department is part of the CG department. Hilmar’s group sat right next door to us, and we frequently traded artists. Tons of work that traditionally would have gone through the matte department happened in Hilmar’s environments group instead, which freed up matte painters to focus on classic matte painting.” The organizational shift was the result of a promise from Lucas — long before work officially began on *Revenge of the Sith* — that the film would require much more in the way of synthetic environments than the previous two. “George wanted to push what was possible with digital environments, and he wanted the matte department to be able to handle anything he threw at it. So, in addition to creating the digital environments group, we put a lot of energy into expanding and maximizing the matte department.” As part of the retooling, the department abandoned its traditional Macintosh platform in favor of PCs and a combination of off-the-shelf and proprietary software. The department also brought in a number of new hires. At its peak, the matte department had 33 artists — twice as many as had worked on Episode II. “The digital environments workload was probably eight times larger than what we did on Episode II, and every frame of every environment had to look as realistic as possible.”



Though laser fire was computer generated, nearly all of the space battle’s explosions, fire, smoke and spark hits were practical elements orchestrated by the ILM specialeffects crew, either on the facility’s outdoor slab or on stage. Working on a greenscreen stage, director of visual effects photography Carl Miller and crew shoot an R4 droidextinguishing a fire on a model of Obi-Wan’s ship.

Zenviro, a new module inside ILM’s Zeno software, was the key to meeting that environments challenge. Essentially, Zenviro was a souped-up version of a projection technique ILM had been using for more than a decade. “Back as far as *Terminator 2*,” John Knoll commented, “we could take an image and project it onto 3D geometry from a particular point in space, and that image would stick even as the camera moved. We used it mainly in our matte department to create a sense of 3D movement in 2D paintings. But it was a real pain to set up in computer graphics, and it didn’t really scale to work on our Maya-RenderMan-Shake pipeline.”

In the break between Episodes II and III, Knoll informed the R&D wizards at ILM that a new projection tool for 3D would benefit the upcoming show tremendously. “What we needed,” related Knoll, “was a super-easy, user-friendly way of doing this kind of camera projection, using a general TD tool. I knew that if it was easy to use, we would use it a lot more.” The result was Zenviro, which uses photographs of live-action sets — taken from every conceivable angle — to create 3D environments. “As long as I got really good pictures of every set piece we had, it was always an option later to make a virtual version out of those pictures using Zenviro. I anticipated using it for cases where we had a small set piece and we needed to make more of it — like a small section of

corridor that I needed to extend into the distance — or if I had to re-create a set because of some new shot George decided to add later.”

Zenviro’s improvement over past 3D photomodeling is that it allows for dramatic camera movement, due to a layered texture approach. “We’ve always been able to texture anything we wanted in a wide shot,” explained Hilmar Koch, “but when the camera flew from the wide shot into a closeup, we wouldn’t have all the detail we needed to make that CG model hold up. Now, texturing has become a compositing operation for us. We’re not just applying a single texture to something. We’re applying layers of texture — derived from the set photographs — one on top of the other. So we have this built-up layer of textures, all of which are turned on at all times, and we can move from one to another as the camera moves closer, revealing ever-greater detail.”

Textures could be derived from photographs of miniatures, as well as full-scale live-action sets. ILM’s model shop built dozens of miniatures that were used either for plate photography directly or as a texture-source for Zenviro. “People always ask why we don’t just shoot all our plates on a model if we already have one,” stated John Knoll. “The reason is that the stage time kills us. Our idea was to limit our stage shooting time to a handful of hero shots, then get everything else with a Zenviro asset, which could be created by a single TD. It was much more efficient and cheaper per element than shooting on the stage.”

Not only was the approach more efficient, it also afforded George Lucas unbridled freedom in changing shot composition or camera moves as his film evolved in the editing room. “Filmmakers always want more freedom with the camera than they can get with miniature photography alone,” Koch said. “They can’t know for sure when they’re shooting the live-action what the final shot is going to be or what the camera movement is going to be. For this kind of movie, especially, being able to bring sets and miniatures into the virtual world was an absolute necessity, because shots could only really be composed once all the elements were there — animation, lightsabers, everything. So the desire was always to have a virtual camera in a miniature set, and that’s what we accomplished with Zenviro.”

Revenge of the Sith opens with a nearly eight-minute space battle in the skies over the Republic capital of Coruscant, as Obi-Wan Kenobi (Ewan McGregor) and Anakin Skywalker (Hayden Christensen) attempt to intercept a Trade Federation Cruiser on which Chancellor Palpatine (Ian McDiarmid) is being held captive by the battle droid commander General Grievous. The complexity of the space battle was such that ILM spent more than a year just building all the starfighters, droids, cruisers and other CG assets it required. “This was the most complicated space battle in any *Star Wars* movie,” said John Knoll, “in terms of number of elements and variety of things depicted. It



Returning to the filmmaking approach he had developed for Attack of the Clones, Lucas shot Revenge of the Sith's live-action in high-definition digital video, on minimal stage sets surrounded by bluescreen, then filled his frames with synthetic environments. For a scene in which Anakin and Obi-Wan fight battle droids in the Federation cruiser's hangar, ILM composited footage of the actors on a small piece of flooring into a vast synthetic hangar set. Lucas' determination to use synthetic environments more extensively than in the past prompted ILM's creation of a 'digital environments group' and development of a new photomodeling technique, dubbed 'Zenviro.'

was also a little different. There has been a space battle of some kind in all six of the pictures; but, for the first time, we set a space battle in the upper regions of the atmosphere — in this case, Coruscant's atmosphere. So it was almost in space, but not quite. We used that as an excuse to do smoke, fire, drag, flak bursts and a lot of other things you can't do in space."

Working from Ranch art department designs, modeling supervisor Pamela Choy and her team produced five massive, highly-detailed cruisers, eight to ten smaller fighters, and dozens of droids, including buzz droids — gremlin-like devices that explode from missiles and dismantle enemy ships manually. Space battle animation — in the past, a largely procedural affair left in the hands of technical directors — was customized for *Revenge of the Sith*, with animators choreographing hero ships and droids. "This time," Rob Coleman explained, "I wanted to make sure we were looking at the space battle from an animator's perspective, looking at what would really be happening to those ships as the battle progressed."

Animation lead Scott Benza went to the Ranch in the early stages of preproduction to work with Lucas and the animatics crew in previsualizing the space battle. Once approved, the animatics were given over to the layout team, which created a logistical distribution of ships for the sequence. "There is a progression in the space battle," said Knoll. "We start at one place, thread through a bunch of ships, and end up at Grievous' ship at the other end. Layout determined what ships were where, and every shot began with that basic space battle arrangement."

Hundreds of smaller dogfights occurring in the backgrounds of hero-animated shots were achieved with a new set of procedural tools written by development lead Neil Herzinger. "If we had half a dozen ships flying in one direction, being pursued by bad-guy ships," said Knoll, "we wanted to have generally plausible, good-looking behavior without a lot of manual labor. So Neil wrote tools to give all those ships some reasonable animation, generally just flying along a Z-axis at a given rate. Then, after we saw a first render of that, we could adjust it or add to it, as needed."



The gigantic hangar was built from a miniature representing approximately one-quarter of the entire environment. Because the hangar was symmetrical left-to-right and front-to-back, digital artists were able to replicate the miniature on both axes, using Zenviro to project photographed textures from the model onto simple geometry.



Modelmakers Grant Imahara and Dave Murphy set intricately detailed panels into the hangar miniature's ceiling.

Technical directors controlled the choreography of weapons fire using improved tools first developed for Episode II. “We needed the laser fire to be as automated as possible,” observed CG supervisor David Meny, “so, rather than having animators decide how a weapon on a droid was aimed and what it would hit, the TDs choreographed that, and also determined what the laser fire frequencies were, and how fast they were moving. All of the ships had templates for where their guns were — on the left, right, top or underneath. So the TD could say, ‘I’m going to be firing from the left half of this ship toward the right half of that ship.’ They could select those guns and auto-aim them at the other ship or series of ships. In addition, there were procedural rules that allowed the aiming to change within a shot and to vary along the length of the ship. These were all capabilities that we didn’t have for Episode II.” Battle damage on the ships was often automated, as well, using Maya’s collision functionality. “We could generate particles for explosions, and when those particles hit a proxy geometry of the high-rez ship, our tools would randomly determine whether that explosion actually blew up the ship or just left a little scorch mark. That kind of setup really streamlined the space battle and created the impression that there was chaos going on everywhere.”

Though the laser fire was CG, 98 percent of the battle’s explosions, fire, smoke and spark hits, and 100 percent of its flak bursts, were practical elements shot on ILM’s outdoor slab by the special effects crew. “We did a handful of volumetric smoke shots for when a ship was flying through,” Meny noted. “And we had some shots with wild camera moves that we knew would be hard to synchronize with practical explosions; so we did do some 3D fireball explosions. But we limited those because it is still very difficult to make CG look as good as the practical stuff.” The only other live aspects of the space battle were production shots of McGregor, Christensen and clone trooper pilots in cockpit mockups. Stagehands manually maneuvered the cockpits on crude innertube rigs to simulate banking and rolling.



A sequence on the Federation cruiser bridge introduces General Grievous, the cyborg commander of the invading droid army, initially conceived by the art department at Skywalker Ranch. ILM spent more than a year developing the computer generated character, contributing to a series of redesigns to ensure that his complex, multi-limbed form could be animated appropriately. A combination of reflective metallic materials and organic tissue, Grievous also presented a multitude of shader and lighting challenges.

The opening space battle shot, which appears immediately after the tilt-down from the *Star Wars* crawl, served as the test-bed for the entire sequence. “We worked out a lot of procedural stuff in that opening shot,” said compositing supervisor Eddie Pasquarello. “It was a great test shot because it was really long and complex, and it encompassed everything that was going to be in the space battle, except the buzz droids. All the other droids and ships were there, so we were able to work out what the cockpit glass would look like, what the flak bursts would look like — everything.” While the space battle proper ends when Obi-Wan and Anakin pilot their ships into the Federation cruiser hangar, the combat continued for another half hour, seen intermittently through the ship’s large panes of glass.

For shots of Obi-Wan and Anakin emerging from their starfighters in the hangar, production had shot the actors climbing out of ship mockups and stepping onto a small piece of flooring. The rest of the 800-square-foot hangar was created from a 1/16-scale miniature. “The miniature represented only about one-quarter of the entire hangar,” noted Knoll, “but since the hangar was symmetrical on both axes — left to right and front to back — we were able to replicate the miniature on both axes to get wide shots. We took texture photographs of the miniature, then created simple geometry and made a Zenviro asset.”

ILM took the same basic approach to extending the cruiser bridge set, the site of Obi-Wan’s and Anakin’s lightsaber match with Separatist leader Count Dooku (Christopher Lee). Just as they had done for Dooku’s combat scenes in *Attack of the Clones*, ILM artists replaced many shots of the elderly Lee with a partial or complete digital double. “Christopher is another three years older than he was in the last movie,” Rob Coleman stated. “He can still move his arms around quite well, but his legs just can’t do too much. So we had a stunt double for Dooku — the same person who doubled him for the Yoda fight in Episode II — and we did head replacements on him. There were also some flips and other moves that were too dangerous even for the double to do; so for those shots we did a fully-digital Christopher Lee. I was pleased with the model because it really looked like him. There’s a lot of closeup intercutting between the real Christopher Lee and the digital double, and it’s seamless.”

To create digital doubles, extensive photographic scans of all the principal actors were obtained during the shoot. “We had six cameras that fired instantaneously,” said Coleman, “capturing one moment in time — as opposed to a 45-second cyberscan around the actor. One of the problems with cyberscanning was that the subjects would move a bit, no matter how still they tried to be, and that would change their dimensions. On the last film, Natalie Portman looked 20 pounds heavier in the scan, simply because she had moved her head a little bit, which increased the size of her noggin.” Modelers did use full-body cyberscans of the actors in specific poses for purposes of comparison. “Once they had made the digital creation, they could compare it side by side to the cyber-data. It gave them something to check against, to see that, yes, he is the right height; and yes, he does have the right proportions.”

In some cases, digital doubles created for the previous episodes were pressed into service, after some retooling to bring them up to current specs. “We had to make sure the old models were compatible with our current tools,” noted creature supervisor Aaron Ferguson, who led the team responsible for animation rigs and simulations on all the soft-body creatures, “so we did some slight updates to their chaining and rigging. We had to do that for creatures from the previous movies, as well. It was surprising to see how much things had changed, especially since Episode I — how much we’d refined the process and how far the science had come. It was usually easier just to



After Grievous abandons ship in an escape pod, Anakin is left to crash-land the severely battle-damaged cruiser on a Coruscant landing platform, aided by ‘firedepartment’ vehicles that arrive to douse flames on the burningspacecraft. While all of the ships were CG, flames were pulled from a library of fire elements shot by the special effects crew. The digital matte department created aerial views of Coruscant seen as the ship makes its fiery descent, including a low-altitude cityscape revealed as the crippled cruiser breakthrough cloud cover.

re-rig and re-envelope those old characters than it was to deal with them as they were, even if it was only for a couple of shots.” One of the few ‘old’ models to make it into the show without revamping was the eopie, the horse-like creature ridden by Qui-Gon Jinn in Episode I and seen at the end of Episode III. Paint touchups made for a more elegant rendering, but the model’s original rigging remained intact.

Acting in anger, and against the *Jedi* code, Anakin executes Dooku. He and Obi-Wan are then captured by the creature/droid hybrid General Grievous and his soldiers. ILM spent more than a year developing the computer animated Grievous, working from Ranch art department drawings and a scan of a foot-tall maquette. “As soon as Pamela Choy started building the Grievous model, we realized there were all kinds of issues with the design,” recalled Rob Coleman. “A particular pose can look great in a sculpture; but when you start moving the pieces around, you can find that they crash into each other or that the character doesn’t have the range of motion he needs. So even though that design had already been bought-off by George, we had to go through yet another design phase in 3D. It’s an inevitable part of the process, but Grievous required more modification than any character we’ve ever done.”

In his final manifestation, General Grievous vaguely resembled a mechanical

Dracula. The slightly lurking, vampire-like behavior, in combination with Grievous’ spidery, multi-limbed physiology, made for some very complex animation. “We did some test performances to develop the insect-like movements,” said Coleman. “Then we added in the vampire idea, and even used a temp voice track that sounded very much like *Dracula*. But George felt that we were going too far down that road, so we pulled back a bit.”

General Grievous escapes the cruiser, leaving Anakin and Obi-Wan to crash-land what remains of the battle-damaged ship on a Coruscant landing platform. ILM’s digital matte department created ever-closer views of the planet from space as the ship makes its rapid descent. “The ship finally descends through the cloud cover,” said Jonathan Harb, “and you see the Coruscant cityscape below. Some of those establishing shots were so complex, a single artist could work on one shot for months.” Initial establishing shots of Coruscant’s surface were 3D matte paintings rendered by Yusei Uesugi and Masahiko Tani. Subsequent views of the Coruscant cityscape were predominantly 3D matte paintings, as well, with 3D geometry or images on 2D cards facilitating 3D camera moves.

Initially, the digimatte group had thought that some matte-painted views of Coruscant created for the previous films might be reusable for the current project. “That didn’t work at all,” stated Harb.



Yoda contemplates the future of the troubled Republic in his Coruscant quarters. An upgraded paint scheme and advancements in digital technology combined to make the character appear more lifelike than he had in *Attack of the Clones* – the first Star Wars episode to feature an all-digital Yoda. Among the most significant advancements was subsurface scattering, a shader tool that gave Yoda’s green skin a more luminous, translucent quality. ILM likewise improved on the Jedi master’s clothing, using short hairs from its fur shader to create pilling on the character’s worn robe.

“Even though we were going to see many of the same buildings we saw in the earlier shows, each establishing shot required all-new work because each had a very specific look. There are shots of the Senate building, the *Jedi* temple, Padmé’s apartment, and we visit each place four, five, six times in the movie — but they had to look different each time, depending on the view, the angle, the mood, the time of day.”

One practical element that was reused for some shots was the *Jedi* temple miniature first built for Episode I. “The *Jedi* temple has always been a miniature, in all three films,” said model supervisor Brian Gernand. “What’s funny is that, even though it’s always been the same miniature, it has looked just a bit different each time because there have been little renovations done for each movie. For this one, we added some texture to the bottom of it, and added a ground plane.” All-new *Jedi* temple miniatures included an entrance exterior and one interior setting.



An ethereal, digitally generated water-ballet performance in the grand opera house on Coruscant serves as the backdrop for a scene in which Chancellor Palpatine (Ian McDiarmid) tempts Anakin with the powers of the dark side. McDiarmid and Christensen were shot against bluescreen, seated on blue-painted chairs. ILM created the model-and-digimatte opera house interior, then populated it with an audience made up of ILM staffers, shot in costume against bluescreen, together with digital representations of characters from all six Star Wars movies.

From his Senate office, Chancellor Palpatine assumes ever more control of the Republic, leading Yoda and other members of the Jedi council to question his motives. An upgraded paint scheme and the use of subsurface scattering — technology that was still out of reach when the original CG Yoda was created in 2000 — made the Yoda in *Revenge of the Sith* appear more lifelike than ever. “Yoda’s skin looks much more real now,” Rob Coleman observed. “You look at the tips of his ears, and you can see light shining through them. They also added more detail in his eyes, like little capillaries, because there are a couple of shots that are very close on his eyes. Those shots are really remarkable.”

Though subsurface scattering made Yoda’s skin look more translucent and organic, it tended to reduce contrast that had been painted into the original hand puppet. “If you look at Yoda in *Empire Strikes Back*,” noted CG supervisor John Helms, “he has a lot of contrast in his face, almost as if they had put eyeliner and lip liner on him. But when we added subsurface scattering, a lot of that contrast was lost. So we painted very specific maps to retain the contrast in those areas. We also made sure we retained all the detail in the maps we had painted for the wrinkles, cracks and age marks all over his skin.”

The look development team was also responsible for major improvements in Yoda’s robe, introducing ‘pilling’ — small nubs of fabric that form on old, worn garments — to give it a fuzzy rather than hard-edged quality. “We used a short CG hair, basically, to make these little pills all over his robe,” explained Helms. “We did that for some of the other CG characters as well; but the main one who got it was Yoda, because we were going to get closer to Yoda than we would the other characters.”

Animators sought to improve Yoda facial animation by cleaning out the existing shape library and creating eight new key expressions that could be accessed using ILM’s proprietary animation software, Caricature. “We could load up those eight expressions,” said Coleman, “hit one button — and there would be ‘concerned’ or ‘meditative’ or ‘angry’ or whatever. And then we could start animating from there. We had basic expressions for the last movie, as well, but we had to dial them in each time. There wasn’t the simple, one-step ‘there you have it’ that we had this time.” In addition to saving animation time, not having to dial in expressions every time maintained consistency in the Yoda performance. “We had 15 animators animating Yoda, and each of them would dial in the shapes just a bit differently, which made the final expression look different. People assume that in computer graphics you’re always on-model, but that’s not true. You’d be shocked



Modelmaker Jon Foreman makes adjustments to the opera house miniature prior to shooting.

how quickly a 3D animator can pull a creature off-model. This time, we could all start with the same main expressions, and that made it much easier to wrangle the team.”

Yoda and the *Jedi* council have reason to worry as Palpatine’s influence on Anakin Skywalker grows. In a scene at an opera house, Palpatine explains to the young *Jedi* the power of the dark side. Christensen and McDiarmid were shot on blue-painted chairs on a bluescreen stage, then were surrounded in post by a model-and-digimatte opera house interior. ILM staffers were shot in costume against bluescreen and cloned to provide the background audience members, interspersed with digital characters from all six films. George Lucas appears as a costumed extra in a digimatte shot of the opera house exterior.

The true power of the dark side, as Palpatine describes it to Anakin, is revealed in a later fight scene between the chancellor and Mace Windu (Samuel L. Jackson). The chancellor counters Windu’s lightsaber attack with the dark force, represented as an electrical current emanating from his hands. The effect, done by the ILM Sabre unit, adhered to the animated, pre-digital look that had been established in *Star Wars*.

Doubles, both real and digital, stood in for McDiarmid throughout much of the fight. “Ian McDiarmid is a wonderful actor,” stated Coleman, “but he would be the first to admit that he is not physical in any way. So he had a stunt double doing the fight scenes. When the stunt double was made up, he looked pretty close to Ian, but we still had to do a lot of head replacements and a couple of fully digital body replacements. I think that was the most successful digital double we’ve made yet. It really looked like him.” Though Samuel Jackson performed much of the fight scene himself, a Mace Windu digital double was needed for a shot of the character being thrust, fatally, through a broken window by the force of the dark side.

In the course of the fight, Palpatine transforms into the Sith Lord Sidious, an effect achieved with makeup and the McDiarmid digital double. “The concept is that using the dark side of the force — especially strenuously — corrupts and ages you rapidly,” said John Knoll. “We shot Ian as Palpatine, and we shot him as Sidious, wearing a prosthetic makeup appliance — and then we had to do four shots in between for the transition.” Crews photographed McDiarmid in both Palpatine and Sidious



The galaxy-wide Clone Wars find their way to the Wookiee planet of Kashyyyk, as a battalion of tank droids advances across a vast lake in a ‘Battle of Normandy’ type invasion. Plates photographed at a distinctive mountain range in China were incorporated into a digimatte cyclorama to produce evocative backgrounds for all the Kashyyyk scenes. Background mist was painted on the cyc, while CG mist elements built up density in the foreground. For shots of digital tanks traversing the lake, ILM blended CG water with practical wake elements shot from a boat. Water explosions and hits were shot in the ILM water tank.



Wookiees prepare to face the droid army on a Kashyyyk beach. Suited performers shot against bluescreen were cloned to create the first few rows of Wookiee warriors. ILM computer generated background Wookiees, using new ambient occlusion tools to create realistic-looking long fur. Motion capture data produced Wookiee animation cycles. Bluescreen and digital Wookiees were composited into a miniature beach setting extended to the horizon with digital matte painting.

makeups, then CG modelers used those photographs to create one model featuring both versions of the character. “They created one mesh,” Coleman elaborated, “and within that were shapes that we could just dial in to go from *Ian* as Palpatine to *Ian* as Sidious.” To prevent the transformation from looking like a non-organic, morph-like effect, some shots retained McDiarmid’s real eyes or parts of his mouth area. “We wanted to continually trick the audience as to when the blend was actually happening.”

While these horrific events unfold on Coruscant, Obi-Wan’s pursuit of Grievous leads him to Utapau, a planet dotted with massive sinkholes into which the Utapauians build their cities. Digimatte lead Brett Northcutt created aerial establishing shots of the planet, projecting stills of grassy areas he shot in the nearby Lucas Valley onto terrain geometry. The sinkholes within that grassy terrain were achieved by projecting photographs of a sinkhole miniature onto cylindrical CG geometry. That sinkhole miniature was one of two that provided the settings for much of the action on Utapau. “We built one entire sinkhole in miniature,” stated John Knoll, “and used that for wide views as ships approach, or looking from the top down or the bottom up. The second model was what we called the ‘hero wall,’ a curved section of sinkhole with a horizontal crack, into which the city and landing platforms are situated. That was designed to be modular and redressable, so that this one hero wall could be a lot of different places — the platform that Obi-Wan lands on when he first arrives, the main plaza we see during the Grievous/Obi-Wan chase, et cetera.”

The complete sinkhole model — dubbed ‘the whole hole’ by the model shop crew — was built at 1/2,000 scale. “It was a ridiculous scale to work in,” said Brian Gernand, “but because of the massive size of the sinkhole — which was supposed to be 5 miles deep and 2 miles wide at the top — we had to consider how big a model we could reasonably build. Even at 1/2,000-scale, this thing was 17 feet tall and 12 feet in diameter, with buildings that measured about an inch tall.” The miniature was sculpted out of foam, then brushed with a layer of melted modeling clay so that more intricate rock texture could be sculpted into it. “It was a way for us to get super-fine detail, without having the pores of the foam showing, which would have been revealed at that small scale.” The hero wall was 1/36-scale, measuring 35 feet wide and 16 feet tall. To allow for multiple re-dressings, the crack in the set was adjustable top to bottom and side to side. “Within that crack were about 150 reconfigurable architectural structures, which stood about three feet tall.” The set also featured reconfigurable sidewalks, street lights and roadways.

Visual effects director of photography Carl Miller photographed the miniatures extensively after shooting motion control plates. Using the scanned photographs, sequence supervisor Jason Rosson built 3D polygonal versions of the sets, which would be used for additional shots Lucas might request after the miniatures had been struck. For shots with very limited camera movement, artists stitched together Miller’s reference stills in 2D, a task that involved months of painstaking work.



Across the galaxy, Obi-Wan arrives at the sinkhole planet of Utapau, where General Grievous is regrouping after fleeing the battle over Coruscant. For aerial establishing shots of the planet, the digital matte department projected stills of grassy areas shot in nearby Lucas Valley onto terrain geometry. Sinkholes dotting the landscape – into which Utapau natives build their cities – were recreated from

photographs of a sinkhole miniature projected onto cylindrical CG geometry.

Sinkhole Level 10 was an entirely CG set. “It was a huge, multi-level warehouse,” said David Meny, “and you could see down five levels. That meant there had to be a lot of detail in it, which made rendering these sequences a real challenge. They were initially 30- to 40-hours-per-frame renders, which just wasn’t going to work. So sequence supervisor David Hisanaga and I mapped out the whole sequence and determined which shots really needed 3D rendering, which shots could be done with stills, and which shots could be reused from other shots. We’d still use the 3D set for every shot, it was just a matter of how we approached it. Could we make do with a single-frame render and track it into the comp like you would with a miniature element that you didn’t shoot motion control? Or did we have to render every frame? As it turned out, only 10 to 15 percent of the shots needed a full 3D camera. And if the camera changed and we needed to see that parallax in some of the shots, we had that capability available.”

On Level 10, Obi-Wan and Grievous engage in a fierce lightsaber contest, Obi-Wan fending off the multi-armed General’s four lightsabers with his single weapon. To train McGregor for the scene, stunt coordinator Nick Gillard actually choreographed two fights — one with Grievous’ upper two arms, and another with his lower limbs. “They actually tried doing it with two stunt guys sparring with Obi-Wan at once,” recalled Rob Coleman, “one standing behind the other, so they could have Obi-Wan fighting all four arms at the same time — but that didn’t work very well. So they had one stunt fellow learn both the upper-arm and the lower-arm parts of the Grievous fight. Then they shot one pass with him just doing the upper arms, and a second pass with him just doing the lower arms. We combined those passes on my Mac on the set, so I could look at the fight with all four arms.”

Once on-set logistics of the fight had been worked out, the animators — led by Glen McIntosh and Greg Kyle — were left with the problem of choreographing the action so that Obi-Wan could plausibly defend himself against four lightsabers at once. “Truth is,” said Coleman, “if he were really fighting someone with four swords, he’d be a goner, because as soon as he blocked two of them, the other two would hit him. Figuring out how to make that work was very difficult, but the animators really got into it. They came up with all kinds of justifications for knocking Grievous a bit off-balance. We had the footage of Obi-Wan’s side of the fight, so we knew exactly what frames he would come in on, and we could take Grievous out of phase slightly at that moment. Even George was surprised by how well we got that to play.”

Unable to beat Obi-Wan, Grievous skitters along a walkway like a spider, then folds himself into his



The majority of the action on Utapau is set within a single enormous sinkhole, represented by a 1/2,000-scale miniature. After carving the basic shape out of foam, modelmakers brushed the miniature with a layer of melted modeling clay, then sculpted crags and crevices into it. The sinkhole was dressed with structures — some measuring only an inch tall due to the miniature’s extremely small scale. Modelmaker Nelson Hall details the sinkhole model. To facilitate lighting and camera movement, the miniature was stood on its side for filming.

unicycle speeder to escape Level 10. A chase ensues through the sinkhole tunnels and the city plaza, ending at a smaller sinkhole platform, where hand-to-hand combat between Obi-Wan and Grievous ends in the General's death. The chase sequence featured a combination of motion control miniature plates and Zenviro environments.

Obi-Wan's transport for the chase is a 40-foot-long lizard-like steed, named Boga. Referencing Komodo dragons and crocodiles, the Ranch art department arrived at a scaly reptilian creature with a large beak and feathers that plumed at the top of its head and ran down the length of its spine. "Eighty percent of its body is scales," said Kevin Reuter. "Some of that scale detail was modeled in, but most of it was done with bump and displacement maps by the viewpainter. We knew we were going to get pretty close to him, so we spent a lot of time detailing the head, giving the eyes reflective and specular qualities that would really make them pop."

A reworking of the flesh engine developed for *Van Helsing* gave the creature realistic skin dynamics as it moved. "The flesh was stable," said Aaron Ferguson, "and it stayed intact, even as the lizard went through all kinds of crazy dynamics. We also knew we'd need a way to constrain the feathers on top of the flesh, so that they would stick to it as it shuffled around. The feathers had to ride with the flesh and react to the dynamics of it, but they also had to be anchored to it." A simulation created basic feather motion as the animal walked or ran, but animators controlled more expressive feather movement. "We felt that if we could control the feathers in animation," explained Rob Coleman, "we could accent Boga's emotion as it went through the scenes. For example, there's a sweet little moment where Obi-Wan goes up to pet Boga, and like a dog it lowers its head and smooths its feathers down so it can receive the pat. At other times, it rears up and pops its feathers out to make itself look more menacing. By not just making the feathers a simulation, we could animate character into Boga at critical moments."

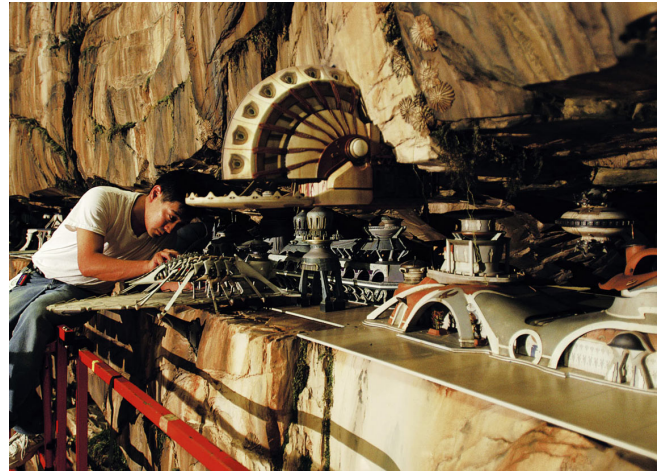
One of the animation issues for the chase was tying a bluescreen element of Ewan McGregor on a motion rig to the movement of the digital creature. In the past, such situations had required splitting the actor at the waist and replacing his lower body with a digital version that could be animated to better match the CG creature's gait. "This has happened on all three pictures," John Knoll noted. "On Episode I, for shots of Liam Neeson riding the eopie, we put him on what we thought was a good rig — a mechanical horse that could reproduce very realistic horse motion; and so we thought we'd be able to animate the CG eopie in a way that looked reasonable. But those shots were a colossal pain! Similarly, on Episode II, our heroes rode these big creatures in the arena sequence. For each of those creatures, we'd worked out how they were supposed to move, and production had built a simulator rig for the actors to ride that — theoretically — resembled how the creature would move. But those shots were also a real pain, and we still ended up having to split our characters at the waist and do the legs CG."

To avoid the problem this time, Knoll and Coleman had requested that animators be allowed to animate the lizard first, then use those motion files to drive the on-set hydraulic motion base on which McGregor would ride. As planned, McGregor would be shot on the rig, not during principal photography in Sydney, but in London the following spring, granting animators plenty of time to animate Boga run and walk cycles, and also affording special effects supervisor Dave Young sufficient time to build the hydraulic rig. Lucas agreed to the plan months before the start of production — but then made a last-minute decision to shoot McGregor atop a generic barrel-type rig in Sydney.

“I’d come back to ILM to see how the modeling was going,” Rob Coleman recalled, “and while I was here, John Knoll called me, and said: ‘Hey, guess what? They changed the schedule, and we’re shooting Ewan on this barrel in two days!’ So I spent the weekend with the only animators I had at the time, which were the animatics guys at the Ranch, and kicked out a run cycle, a walk cycle, a leap. We actually animated it on a little barrel, similar to what they’d have on the set. We sent that animation to Sydney, they played it on the monitor, and the boys on set tried to match it as closely as possible, by eye. Not surprisingly, we ended up with live-action footage that was incredibly difficult to use. As a result, we had to do a lot of digital double work in those scenes. We did everything in the book — full digital Obi-Wan, full digital body but keeping his real head, keeping the head and torso but replacing everything from the waist down.”

Across the galaxy, Yoda establishes a command post on Kashyyyk, an overcast, misty world forested with 1,000-foot-tall trees in which Wookiee natives build their villages. The initial reveal of the planet as Wookiees fly in on catamaran-like gliders proved to be one of the most challenging environment shots in the show, combining aerial plates with miniatures, 3D geometry and digital matte-painted elements. An aerial plate shot in Thailand by Carl Miller provided the base element for the Kashyyyk reveal. “In Thailand,” explained Roger Guyett, “they did a tracking shot across the ocean, which then came around an interesting rock formation to reveal a bay. That gave us a place to start, but we wound up stripping almost everything away from that plate and adding in our own elements. Sometimes we wonder why we bother shooting something like this in the first place, considering how much we change it. But it is always best to start with some kind of reality, no matter how much you ultimately change it.”

Among the changes made to the Thailand plate was a replacement of the far background with plates Guyett had shot in China, his first order of business when coming on the show in August 2004. “George had a particular liking for this mountain range near the Yangtze River,” Guyett said. “I

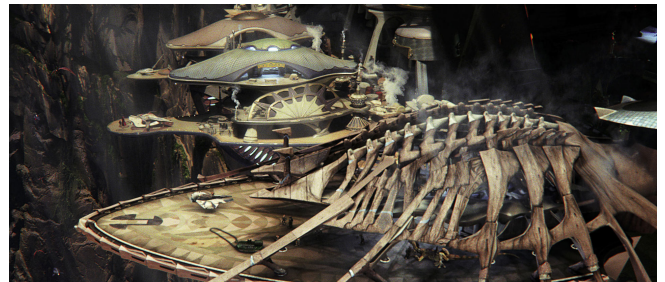


The model shop also built a larger-scale sinkhole wall section. The miniature was reconfigurable and could be dressed to represent a number of locations featured in the Utapau sequence. Modelmakers built 150 architectural structures which could be mixed and matched within a horizontal fissure that was adjustable top to bottom and side to side. Modelmaker Grant Imahara adds final touches to a landing platform on the sinkhole wall miniature.

think he had originally seen these mountains when he was working on *Young Indy*, and he really liked the unusual look of them; and so, he was enthusiastic to see them in this movie. I spent about three weeks in China, shooting those plates.”

The plates became part of a digimatte sky-and-mountain horizon cyc surrounding all of the Kashyyyk settings. Digimatte also replaced the bay in Thailand with a painted lagoon and beach for the big reveal. Foreground trees were a miniature, shot motion control, with CG trees filling the frame to the horizon. “Once you round this bend,” said Jonathan Harb, “you are looking at the miniature tree, CG trees, and matte-painted beach and water, with a reflection of the beach matte painting in the CG water. On top of that, there were creatures running around and the catamaran ships flying in. Making all of that stick together was very difficult for the compositors and layout, especially since the original helicopter plate was fairly unstable. It was a huge matchmove task, and a huge compositing task, requiring a lot of subtle retimings to smooth everything out in the shot.”

Establishing scale in the big reveal was another challenge. “We had to play around with the scale of the trees,” said compositing supervisor Pat Tubach. “They are supposed to be 1,000 feet tall, but they were right next to a real rockface, and making those two things look right side by side was very difficult. We also had to play a lot with color to get the sunlight and the mood right. George was very specific about the look of this shot. He wanted it overcast, but he did not want it to be so dark that we couldn’t see everything. He wanted it shrouded in mist, with the sun burning through the clouds. The background mist was part of the digimatte cyc, and then we added CG mist elements to create density in the foreground.”



For wide views of the sinkholeplatform area where Obi-Wan lands his ship, ILM extended the miniature photography with 2D and 3D digital imagery. The digital environments group also created ‘Level10’ – where Obi-Wan engages Grievous in a lightsaber duel – as an entirely CG environment. The amount of detail in the huge 3D set initially made for prohibitively long render times. To decrease the rendering burden, digital artists went through the Level10 scene shot by shot, determining which ones needed full 3D rendering and which could be achieved through a 2D approach.

A 1/72-scale carved foam tree was cloned to create all of the hero trees in the Kashyyyk sequences. Scaled architecture built within the trees reinforced the idea that — unlike the primitive Ewoks of Endor — the Wookiee tree-dwellers had established a very high-tech and sophisticated society. “We were emphatically instructed that this was to have absolutely nothing to do with Ewok culture,” said Brian Gernand. “It had to be much more high-tech than that. All the buildings had very beautiful, sophisticated wood inlay. The model also had arched doorways carved into the trunk, indicating a labyrinth of rooms and stairwells inside the tree. Then, out on the branches were all these beautiful, pagoda-like huts, with suspension bridges spanning between them.”

The 12-foot-tall miniature had interchangeable limbs so that it could be reconfigured to represent a whole forest of trees. “These trees are so massive,” said Guyett, “in any given shot you’re seeing very little of any one tree; so there was no way to know that it was all the same miniature. All we’d have to do is rotate it a bit. We were able to get quite a lot out of some fairly simple components.”

The miniature is seen most prominently as the hero tree in which Yoda establishes his war room. The model shop built Yoda's treetop command center as a separate, 1/8-scale model, fashioned out of natural teak wood. Visual effects director of photography Marty Rosenberg shot the war room and tree miniatures motion control; then CG versions of the trees were built from scans of the miniature. Sequence supervisor Pat Conran also added CG foliage to the leaf-less miniature tree and its clones.



The complexities of realizing a convincing duel between a live actor and a CG character were multiplied due to Grievous' four arms, each wielding a lightsaber. During principal photography, stunt coordinator Nick Gillard choreographed a fight between Ewan McGregor and a blue-suited stuntman who first performed only the actions of Grievous' upper two arms. Production then shot a second pass of McGregor fighting the stuntman as he performed the lower-arm action. In post, ILM replaced the stuntman with Grievous. Animators duplicated the original fight moves, tweaking the performance to make the general lose his balance at times – justifying Obi-Wan's victory in the uneven fight.



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Except for scenes with Peter Mayhew as Chewbacca and a handful of other hero Wookiees that George Lucas had shot during main unit, all of the Wookiees seen on Kashyyyk were either CG or, more often, bluescreen performers in suits that Rob Coleman shot second unit in Sydney. “Rob had always wanted to direct performances,” said Rick McCallum, “so we gave him the opportunity to shoot Wookiees for a week in Australia. It was a perfect opportunity to elevate him to that position — and he did a great job.”

The five bluescreen Wookiee performers, all Australians, stood about seven feet tall without the risers in their Wookiee boots. Muscle suits worn under the fur suits also added to their bulk. Due to the heat generated inside the furry suits, performers could work for only a few minutes at a time in front of the cameras. “They had cool suits,” said Coleman, “but they would still overheat after about 20 minutes and have to take the heads off. To deal with that, I kept rotating them, letting a couple cool off while I shot a couple of others. We had animatics for 40 Wookiee shots, and we shot all of that stuff. Then, in the last two hours of the last day, we shot some wild stuff — Wookiees cheering, shooting, running, et cetera.”

Back at ILM, a crew motion captured one of the original Wookiee performers to create animation for the CG Wookiees featured in heavily-populated wide shots. “Having one of the real Wookiee performers do the motion capture work was super-valuable,” remarked Coleman. “It was a lot better than having a six-foot-tall person doing the actions, and then trying to translate that to a seven-foot-tall Wookiee. That extra foot on these guys makes their strides different, their weight transfer different. So we got the biggest guy from the original shoot and put him in an XXXXL mo-cap suit. And because it was the same guy, everything he’d done in Sydney came across the same on the mo-cap stage.”

The motion capture sessions produced animation cycles that were applied to the hundreds of background CG Wookiees. Though Wookiees would be individualized with different armors and weapons, a single CG model endowed with every variety of hardware was used to produce entire armies. “We created an ‘über-Wookiee,’” explained Kevin Reuter, “which had four different types of weapons on it. The animator would decide which weapon he wanted any particular Wookiee to use in a given shot, and the rest of the weapons would be turned off at render time. Aaron Ferguson’s creature group simulated varieties of armor.”



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The creature and look development groups also grappled with creating digital Wookiee fur. Production supplied ILM with one of the Wookiee suits, giving the teams tactile reference from which to start. “Every *Star Wars* fan knows what a Wookiee looks like,” Reuter remarked, “so we had to re-create that look exactly in the CG Wookiees.”

Though these same teams had solved a number of fur issues for the werewolves in *Van Helsing*, the huge numbers of Wookiees in the Kashyyyk scenes required that the technology be improved considerably. “We had to figure out a way to do the hair very quickly,” Ferguson remarked. “We developed techniques that allowed us to simulate hair and then repurpose it on different animations. We could run a hair simulation and then allow for the animation to be changed subtly, and the hair would respond accordingly. That was nice because a lot of the Wookiees were done with animation cycles, and we needed to be able to adjust things when we were blending two cycles, without having to re-simulate the hair for all of those cycles.”

Pat Conran also developed a new method for simulating long-hair ambient occlusion on the fur, which involved first executing 200 Wookiee renders from all different angles. “Pat would come up with an average amount of occlusion for every CV on every hair from each of those 200 angles,” explained Reuter, “and write that out into its own file. Then, we would read in that file whenever we did the hair generation process. That gave us a really nice feel of the hair occluding itself, which was something we’d never had before. People have been trying to simulate ambient occlusion for fur for a long time, and we’ve done approximations in the past; but this was a new way of going about it, and it gave us a much better look.” An advantage of the long Wookiee fur was that it required fewer individual hairs. The first Wookiee model was rendered with 800,000 hairs; but for shots featuring dozens to hundreds of Wookiees, an 800,000-hair fur was too dense for efficient rendering. “At that density, we could render only two Wookiees together at a time. We began to realize that the closeups were going to be the guys in suits anyway, and ours were just going to be distant Wookiees; so we reduced the number of hairs, and got it to where we could render a decent Wookiee that was pretty comparable to the live-action one with about 150,000 hairs.”

The central Kashyyyk sequence is a ‘Battle of Normandy’ scene in which an army of Wookiees defends a beach from invading tank droids. Both bluescreen and digital Wookiees populate a big boom shot at the start of the battle. “When you see the group of Wookiees jump up and cheer,” said Coleman, “the first few rows are real performers from my little group of five or six Wookiees, which I shot over and over again. We were on a big Technocrane, and the crane operator did a fantastic job of just eyeballing that move. Then, back here, Jason Snell and his matchmove group, and Brian Cantwell and the layout group, took all of that footage and corner-pinned it so that it looked like it



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had been generated from one camera — when in fact it was probably eight passes, with a wild camera on a wild Technocrane.”

All the Wookiees beyond the first few rows were digital. “It was very difficult to get the CG Wookiees to match the real characters standing right in front of them,” remarked Pat Tubach. “There was a lot of tweaking of fur colors and patterns in the render and in the comp to make that match. The lighting had to be just so, as well, to really make them look as if they were standing next to one another. As you go further and further back, we had to add these masses of furry creatures, and make them sit just so in the back of the plate.”

The model shop built a 1/8-scale beach miniature for the battle scene and other Kashyyyk shots. The miniature was covered in super-fine sand to scale it appropriately, and featured dozens of bunkers, tank traps and other Wookiee war gear. The beach miniature was shot both as a motion control element and as a photographic element. “Sometimes we would go for a textural approach,” commented Roger Guyett, “photographing the beach model and putting those photographs on cards for the wide shots. And then, for specific foreground pieces, Marty Rosenberg shot the miniature motion control. We shot it clean for before the battle, then messed it up for shots after the battle.” Compositors created interaction on the miniature during the battle by comping in explosions and other practical elements.

Reverses showing the tank droids racing across the lake toward the beach required a melee of hits, sprays, wakes and other interactive water effects, many of which were shot in ILM’s tank. “I wanted to do something that would look slightly different than the standard water explosion,” related Guyett, “so we experimented with really bright high-tech flashes inside the water hits. Special effects supervisors Robbie Clot and Geoff Heron worked hard to get the look I was after.”

To capture water interaction that would tie to the speeding tank droids, Guyett’s team attached a tank-shaped rig — built by the model shop — to a real boat, and shot wakes at the Berkeley Marina. When the boat could not travel fast enough to create appropriate turbulence, the team resorted to using CG water. “The tank droids travel at such incredible speed,” Guyett said, “we needed wakes that would suggest that. The ones we got with the boat on real water worked all right for background wakes, where you could get by with a slower speed; but for the foreground wakes, it was just impossible to make do



In the penthouse apartment of Padmé (Natalie Portman), Obi-Wan breaks the news of Anakin’s turn to the dark side. McGregor and Portman performed the scene on one of the few complete sets built for the show by production designer Gavin Bocquet. Views of the Coruscant skyline outside the apartment were generated by the digital matte painting team. Initial plans to reuse some of the Coruscant imagery created for Episodes I and II were scrapped when it became apparent that each shot in the new film had specific lighting and camera-angle requirements.



The climactic battle between Obi-Wan and Anakin takes place on Mustafar, a volcano planet on which rivers of molten lava flow through rocky canyons. To avoid the costly and time-consuming prospect of creating CG lava for hundreds of Mustafar shots, ILM instead filmed practical ‘lava’ – bright yellow-tinted methocel – flowing through a series of carved-foam rock formation sets. Clear

with the real elements. So we wound up speeding some of those up and then using them in conjunction with CG water. All of the water you see in the wide shots is CG, as well.”

lexan in the lava riverbeds allowed for bottom-lighting to simulate a fiery glow. A lava crust made of ground cork enhanced scale in the miniature setup.

Lucas requested that the CG water be clear and lagoon-like, revealing the lake bed below. “There also had to be light play through the water,” remarked CG supervisor Craig Hammack, “and light bouncing off the water. We needed to see reflections, parallax in the reflections during large camera moves, and refraction under the water. All of that added complexity to the CG water work. We were fortunate in that RenderMan ray-tracing had come about some time before this. Since this was a fully synthetic environment, we had things to bounce our rays off of; we weren’t just trying to fake reflections of practical images. We were able to transfer digital matte paintings and CG geometry into RenderMan to get correct reflections. We also used ray-tracing tricks to contaminate the water, as if the bottom was being churned up a bit.”

Back on Utapau, Obi-Wan is about to recapture Level 10 when his clone troopers turn on him — the result of the chancellor’s ‘Order 66,’ which brands all *Jedi* enemies of the state. The galaxy-wide shift in loyalties is illustrated in a series of vignettes set on different planets, each revealing *Jedi* in battle with the troopers. Among the planets briefly visited in the Order 66 montage is Felucia, an eerie world covered in giant, translucent plantlife, created digitally. The model shop built plant miniatures in resin, which were then shot in smoke and in various lighting setups to provide the CG teams with reference images. The colorfully translucent look of the foliage was the result of subsurface scattering and other shaders fine-tuned by CG supervisor Pat Myers. To avoid heavy renders, the shader information was baked out and used only as needed, depending on camera and light angles.

Another planet visited in the Order 66 sequence is Mygeeto, a crystalline environment with glass-like cities built into stony buttes. “The lighting on Mygeeto is very gray and diffuse,” said John Knoll, “because there is ash falling, as if there has been a volcanic eruption. There is a big battle in the ash, with Ki-Adi-Mundi leading a bunch of troops, which then turn on him.” CG bridges spanning miles of space between crystalline cities were surrounded by a digital matte painting by Paul Huston. “There was a main bridge that the hero *Jedi* were fighting on,” explained Craig Hammack, “and digimatte did everything surrounding that bridge. Then we added the ash.” Ash kicked up in the air during the fighting was most often a particle simulation. Falling ash was achieved practically, by shooting finely-ground cement mixture out of air cannons.

Clone troopers on all of the planets were designed to reflect their acclimation to each respective environment. “On Mygeeto, for example,” Rob Coleman commented, “the clone troopers wear a face covering because of all the falling ash. On Felucia, which is a very tropical world, the troopers wear camouflage. The thought was that if you were an army of clones and you all looked alike, after a while you would start to do things to individualize yourself



Greenscreen stage elements of McGregor and Christensen performing choreographed fightmoves on simple green-

— like the soldiers in Vietnam who would write things on their helmets and wear patches on their uniforms. It not only made sense from a story standpoint, it was a good idea because, of course, one of the problems in computer graphics is that if you create an army of clones from the same model, it looks like a CG trick. So I was happy that they decided to add all these different paint schemes to the troopers, with different armor and weaponry and coloring.”

painted set pieces were composited into the miniature environments.

Animators studied combat films such as *Black Hawk Down* as reference for a more gritty style of street fighting than the troopers had exhibited in the previous films. “George wanted the troopers to look more like commandos than just marching armies,” stated Coleman, “which is what we had done before. This time, we created the look of soldiers infiltrating hostile areas, like what you see on the evening news from *Iraq*. The camera is down low and we’re moving with them.” Animators tweaked and refined motion capture data to produce trooper animation.

Anakin’s embracing of the dark side leads to his fateful duel with Obi-Wan on the volcano planet of Mustafar — the stuff of *Star Wars* legend. Three hundred effects shots were required to realize the climactic sequence. Wide establishing shots of Mustafar — POVs of arriving ships — were composites of digital matte paintings and layers of practical elements. “We added a lot of stuff to those establishing shots to help the scale,” said Pat Tubach. “We had actual volcano events shot at Mount Etna in *Italy*, and we put a ton of those in.”

“Mount Etna started to blow up one weekend,” Rick McCallum recalled, “so I called up Ron Fricke to get over there and shoot it — and we were literally a quarter of a mile from the volcano 24 hours later. We shot there for 10 days, and a lot of that spurting lava wound up in the movie.”

Compositors also blanketed the entire painted landscape in smoke and added live lava elements acquired by shooting a methocel-based mixture — a formulation that would figure heavily in shots following Obi-Wan and Anakin as they duel in and around locations surrounded by hot, flowing lava. The fight starts within an industrial complex situated high on the rocky banks of a vast lava river, then moves onto a heat-collection arm that stretches out over the roiling magma. When the giant arm collapses and tumbles over a lava falls, Obi-Wan and Anakin swing on cables to land on a rocky bank. The battle ends there with Anakin severely burned and maimed.

Computer generating lava and environments was not a cost- or time-effective approach, due to the

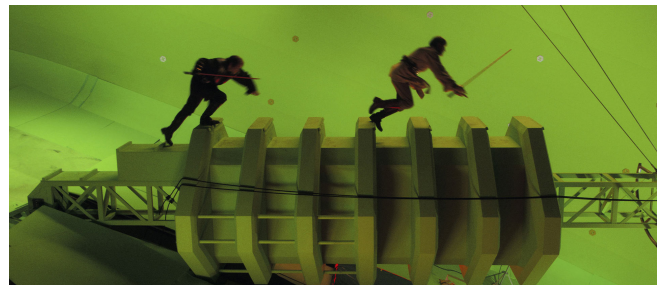


large number of shots in the sequence. *Instead*, Roger Guyett conducted tests in which crew members poured methocel — a thickening agent — through a series of miniature sets. The results were promising, and the model shop began work on three 1/132-scale sets: the upper river area surrounding the industrial complex — interiors and exteriors of which were computer generated — a lower-river set and a lava falls set. A fourth miniature, dubbed ‘Anakin’s burn bank,’ was built at 1/36 scale. “We went to a much larger scale for that,” stated Brian Gernand, “because it was a hero area and we had to get much closer to it.”

The climactic lightsaber contest starts inside an industrial facility, then moves onto a metallic heat-collection arm that extends over the rushing lava flow below. To augment the practical methocel-lava photography, digital artists created specific lava ‘events’ – such as sprays of magma shooting into the air and glowing debris falling near the characters – by generating particle simulations in Maya. Actual volcanic activity – shot in Italy during a fortuitously-timed eruption of Mount Etna – provided additional live-action enhancement to the sequence.

All of the miniatures were carved out of foam, with three-quarter-inch clear lexan in the riverbeds allowing for bottom-lighting to simulate a fiery glow. The methocel was tinted day-glo yellow; but the miniatures crew was able to vary the hue by controlling the depth of the methocel as it moved along the lava-bed sets. “We found that in real life, cooling lava is bright orange, while hotter lava is bright yellow,” explained Gernand. “So we designed our sets so that the lava would flow at different depths. When the methocel moved into the deeper areas, it magically turned a burnt orange just because of the volume. When it was out in the edges, where it was more shallow, it was thinner and bright yellow. We added little clear bumps in the set, as well, and when the methocel traveled over those, it would become thin and turn yellow.” A dressing of cork to create a crust helped to impart scale. “We learned that the crust was the most important thing in making the lava look realistic. We added a binder to it to make crust pieces clump together at the bottom of the set, bunching up around pinnacles and into corners — just as it does on real lava as the movement slows.”

Crews recycled the many thousands of gallons of methocel used for the shoot through an elaborate filtration and pump system. “After filtering out all the pieces of crust from it,” said Gernand, “we pumped the clean methocel from the foot of the set all the way up to the head. We could circulate the material and run it for hours, which was really beneficial. It wasn’t a one-take thing where, once we ran the methocel through, it would be hours or days before we could do it again. The recycling system allowed us to do it over and over again, very quickly.” The ability to do multiple takes in a short period of time enabled visual effects director of photography Pat Sweeney, who shot all the Mustafar miniatures, ample opportunity to perfect lighting levels.



McGregor and Christensen were photographed against a greenscreen, clambering over a collection arm set piece, laid flat for ease of movement. The arm was tilted to a more precarious angle in the final composite. On-set steam blowing on the actors helped to marry the characters to the volatile Mustafar environment, but made matte extractions more difficult. Composers integrated additional steam elements into final shots.

The preliminary testing had convinced Guyett that a fast-moving lava flow would make for a more dynamic sequence than a slower-moving flow. “Most people expect that lava would move very slowly,” remarked Guyett, “but, in reality, lava flows at all different rates of speed. Magma actually flows like water sometimes, because it is so hot. So there was a real-world basis for making the lava

move rapidly; and, of course, it also made the shots more exciting. Slow-moving lava is incredibly boring to watch.” Crews had already shot many days’ worth of fast-moving methocel footage when Guyett asked George Lucas how fast he thought the lava should move. “He said, ‘I guess it should be moving pretty slowly.’ That was my aneurysm moment on the show. I thought, ‘Oh, God, I’ve really screwed up here!’ But when I showed George our slow-moving tests and then our faster-moving stuff, he agreed that it looked more interesting moving fast.”

The model unit shot the Mustafar miniatures for a full eight months. “I believe it was the longest single miniature shoot in ILM’s history,” said Guyett. “There was every sort of setup, and they were all immensely complicated.”

To give Guyett the ability to direct the lava more specifically, the model photography was augmented with methocel elements that had been shot separately, at night, on ILM’s outdoor slab. In addition, digital artists created large-scale lava ‘events,’ such as fiery plumes erupting into the air. “We really needed the digital work to make the most of those miniature pieces,” said Guyett. “In addition to CG lava sprays, we added CG events to help the scale, such as ‘bloops’ coming up through the methocel lava.” Using Maya and proprietary plug-ins, sequence supervisor Willi Geiger generated particle simulations to create the lava elements. In some cases — such as lava closeups in which the miniature photography crew had been unable to hold focus, or shots in which the scale of the methocel lava did not read appropriately — digital artists replaced the practical lava flow with a simple surface shader.

The miniature sets were also extended with 2D and 3D environments. “Digimatte put together background 2D cycs that had running footage in them,” stated John Helms, “and in some cases we mapped textures from the miniatures onto 3D geometry. We also had a lot of photographs of the miniatures that we could use if we just needed a piece of something we hadn’t originally shot.”

The exterior Mustafar environment is fully revealed as Obi-Wan and Anakin run out onto a large pipe that leads to the collection arm. Production had photographed the actors sparring on a bluescreen beam, with practical steam blowing on them to tie in with the roiling magma that would be added later, in postproduction. “It was a huge challenge to pull those bluescreens and integrate extra steam elements with the steam that was already there,” commented Pat Tubach. “We also had to put the characters on top of a CG pipe that didn’t really exist, and stick their feet to it. And to make it even more difficult, Roger wanted to add a little bounce to that pipe. Throughout all this we had lava events happening everywhere, with a big landscape in the background. Most of the shots had the characters pretty small in a very large environment, so we had a lot of space to fill.”

Obi-Wan and Anakin continue to fight atop the collapsed collection arm as it rushes toward the lava falls. The miniature crew had built and shot a set leading up to the edge of the falls; but both the tumbling lava and collection arm were computer generated. In addition to giving the falls a greater sense of scale than what could have been captured on the miniature setup, CG lava allowed for much more dynamic lava movement. “Niagara Falls was one of our references for the look of the lava falls,” noted John Helms. “We created huge simulations to make the lava pour over the edge and swirl around and shoot up.”

On the bluescreen stage, Hayden Christensen performed the final scene on Anakin’s burn bank wearing a disturbing burn makeup and bluescreen gloves and stockings so that his ‘severed’ limbs

could be matted out. Compositing tricks yellowed the actor's eyes and highlighted or dulled specific areas of the makeup, as needed.

A series of denouements brings the sad saga to its end. On the Polis Massa asteroid, Padmé dies giving birth to twins Leia and Luke. For her state funeral on Naboo, production shot only a small procession and a casket. ILM extended the procession and filled the frame with 3D and 2D imagery, painted by lead digital matte artist Yannick Dusseault and matte artists Johan Thorngren and Paul Huston. "We added *Star Wars*-style horses," recalled Craig Hammack, "and created huge crowds by shooting groups of ILM crew people against bluescreen. Surrounding all of that was the big digimatte environment."

Originally, the movie's final moments were to include Yoda's arrival in Dagobah, where the *Jedi* master will live in seclusion until sought out by a young Luke Skywalker 18 years later. The very day crews finished shooting the Dagobah miniature, ILM learned that the sequence had been cut. "We had done a shot of Yoda's little escape pod landing there," said John Knoll. "Then the door opens, and there is Yoda looking out on the landscape. We built a swampy tabletop miniature for the immediate foreground, and we had little creatures scuttling on the ground. Unfortunately, *George* had to cut the scene for time."

Although ILM's modelmakers failed to get their iconic Dagobah miniature into the movie, they felt honored to contribute a significant *Star Wars* artifact — the black face mask and helmet that are attached to Anakin when he is reborn as the part-man/part-machine Darth Vader. Don Bies, a longtime *Star Wars* veteran and R2-D2 wrangler, built the headpieces from molds of the original costume. "It wasn't that it was such a big job," observed Brian Gernand, "but it was kind of the crowning moment of all six films — the moment Anakin becomes Darth Vader." The mask and helmet are seen from Anakin's POV on an operating table, being lowered onto his head on a mechanical arm. "We shot our full-scale mask and helmet pieces on a mechanized rig. The mask came down and sealed itself onto Anakin's face. Then the helmet came in and snapped onto that." The Vader headpieces were shot at ILM against bluescreen, then added to live-action of Hayden Christensen on the table. CG hoses and clamps attaching to Anakin added life to the scene.

Final vignettes show babies Luke and Leia being delivered to their respective adopted homes. For a short scene in which Bail Organa (Jimmy Smits) takes baby Leia home with him to Alderaan, Yannick Dusseault, Brett Northcutt and Christian Haley created a 3D matte painting using elements shot in Switzerland. "We see a couple of wide vistas of the Alderaan starcruiser approaching the city and landing," explained John Knoll. "Then we see Bail Organa bringing in Leia. That entire Alderaan set was about eight feet of bench — that was it."

Production had had the foresight to shoot a plate for Obi-Wan's delivery of Luke to the Lars family homestead on Tatooine when crews were on the set in Tunisia for Episode II. Digimatte artists not only extended the plate, they radically altered it. "We had to almost redo it all," said Jonathan Harb. "*George* had very specific requests for where everything was on Tatooine. So we made a quick little 3D environment, and augmented that with photographs from Tunisia to create a wide panorama." Digimatte also added the multiple suns of Tatooine and a spectacular sunset. "*George* knew exactly how the sunset should look. We went on a big sunset hunt and when we finally found one that he liked, he wanted it to be exactly that sunset. He warned us — 'Don't you paint on it!'"

As work on *Revenge of the Sith* neared completion, Industrial Light & Magic — which had been spawned to create the effects for the original *Star Wars* — prepared to vacate the facility that has housed the company for the past 25 years and move to new digs at the Presidio in *San Francisco*. Staff members and artists moved through the emptying halls and offices with bittersweet feelings of a mission accomplished, of a creative endeavor that was forever in the past — despite whatever ‘special edition’ tweaking Lucas might one day entertain. Among those who felt a heavy closing on a chapter of their lives was *Rob Coleman*, who had spent nearly half his professional career dealing exclusively with Episodes I, II and III of *Star Wars*. “I don’t think it is fully going to sink in that this is over until I see the movie with sound and music,” Coleman reflected, “and then I may cry, because then it is truly over. It will be emotional for me.”

Having first entered the world of *Star Wars* with his work on the Episode IV, V and VI special editions, then moved on to supervise effects for the new trilogy, John Knoll has spent an entire decade bringing *Star Wars* imagery to the screen. “I have very mixed feelings about this final film being completed,” Knoll observed. “It has been a big chunk of my life, and it’s been great fun. I’ve really enjoyed doing them, and working for *George*. I’ve also grown a lot as a supervisor. Not only have I learned an enormous amount in the exercise of doing these three pictures, the experience has made me absolutely unafraid of big shows. Going into Episode I was a really scary thing, because it was so big and we were going to do so many new, untried things. I thought at the time, ‘If I survive this, no show, no matter how big, is ever going to faze me again.’ And it has been that way. I’ve done the biggest, so there’s nothing that can scare me now.”

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Mostly Harmless

image

ARTICLE BY JOE FORDHAM

In 1971, backpacking Cambridge graduate Douglas Adams lay in a field in Innsbruck, Austria, and pondered the mysteries of the sky. Inspired by his copy of Hitchhiker's Guide to Europe, Adam's slightly inebriated ruminations produced the spark of what would become The Hitchhiker's Guide to the Galaxy — a science fiction satire about suburban British earthling Arthur Dent, cast adrift after the destruction of his home planet and sent spinning through the universe with only a bath towel and a talking, computerized guide book.

After the BBC first produced the whimsical saga in 1978 as a six-part radio series, Hitchhiker found form as a stage play, novel, record album, television series and computer game. Further literary installments comprised what Adams dubbed 'a trilogy in five parts.' Adams was working on his long sought-after Hitchhiker feature screenplay when he succumbed to a fatal heart attack, at age 49. Screenwriter Karey Kirkpatrick completed the unfinished work, sharing screenplay credit with Adams, when Spyglass Entertainment producer Roger Birnbaum brought the project to British music video and commercials company Hammer & Tongs. Producer Nick Goldsmith and director Garth Jennings seized the material with gusto and proposed an approach to unlock Adams' vision, after 27 years.

"The story had previously been envisioned as a big-budget Hollywood movie," commented visual effects supervisor Angus Bickerton, who joined the team nine months into preproduction, working alongside visual effects producer Andrew Fowler. "That was where the studios balked slightly, because the story was rather eccentric and I don't think they could see it warranting that kind of expense. Nick and Garth proposed a way to make the film viable for a more moderate budget using very simple in-camera effects, as Garth had done in his music videos. If a sequence became too unwieldy, they would pare it down, and say, 'Let's think about how we can make this work in a different way, without undermining Douglas' concepts.'"

Backed by Spyglass and Walt Disney Pictures, Hammer & Tongs and production designer Joel Collins embarked on a 10-month exploratory design period. The art department shared data with an in-house effects department, 'Mostly Harmless Visual Effects,' a moniker derived from the title of the fifth Hitchhiker novel. "There was a lot of good thought put into making the art department and the visual effects meld," remarked Bickerton. "They used Cinema 4D for previz and concepts, building objects in 3D that they could then export into Maya for use in visual effects."

The in-house effects approach, led by visual effects supervisor Jon Hollis, was abandoned in favor of using an established effects facility; but those initial designs helped secure a greenlight for the film and became a template for production. Cinesite in London led effects development overseen by visual effects producer Ken Dailey and visual effects supervisor Sue Rowe, who ceded duties to Adam McInnes and Matt Johnson when she took maternity leave. Asylum Models and Effects acted as an early production base and produced specialty props and mechanical effects. Motion graphic and commercials design company Shynola concentrated on animated screen readouts, particularly

the Hitchhiker's Guide, while Jim Henson's Creature Shop embarked on robot and creature designs. Physical effects supervisor Paul Dunn at Special FX UK Limited and miniature effects supervisor Bill Pearson rounded out the team.

Arthur Dent (Martin Freeman) witnesses his first overtly alien encounter when emissaries from the planet Vogosphere, sent to obliterate earth to make way for an interstellar bypass, arrive in the sky over his home. For the Vagon spaceships — which resemble giant, floating slabs of concrete — the miniatures team took inspiration from full-scale Vagon sets built at Elstree Studios. “The Vagon ships were actually buildings,” said Bill Pearson. “They were like skyscrapers made out of concrete — flat-sided, without a lot of features, but looking like they'd been around for a thousand years.”

Miniatures of Vagon spacecraft — four-mile-high constructor ships and mile-high destroyers — needed to be lightweight, but robust. Pearson's team sculpted detail into 80-kilogram-grade polyurethane foam slabs, treated the surfaces with resin, made negative vacuform patterns of textures, then cast inversion molds from which they pulled sturdy vacuform impressions with crisp detail. Modelmakers affixed the four-by-four-foot panels to ten-and-a-half-foot-tall by three-and-a-half-foot-square miniatures, then stippled the surfaces with resin and spray glue, and painted the miniatures with acrylics, applying rust and grime around engine ports. Cinesite's matte painting team, led by David Early, used photographs of the destroyer and constructor ships — shot by Angus Bickerton — to build 4K digital textures, which were projected onto geometry and enhanced with atmospheric layers to place spaceships in perspective over international cities and the English countryside.

Piloting the fleet is a race of extraterrestrial bureaucrats, the Vogons, partially inspired by James Gillray's late 18th-century caricatures. “Garth saw the Vogons as the seediest, most gout-ridden gentlemen in the universe,” observed Henson Creature Shop creative director Jamie Courtier. “Vogons were not concerned with their image whatsoever. They were issued one set of clothes when they were born that would stay with them for the rest of their lives, along with all the breakfasts they had spilled along the way.” The creatures were realized as an army of seven-and-a-half-foot-tall animatronic creations. “Garth's philosophy was that this was a film that cried out for animatronics. While that technology might be considered a bit of a blunt instrument in today's ever more detailed and realistic CG vision, animatronics are still relevant and sometimes more accessible to an audience. You feel it a bit more in your heart. And Hitchhiker was always more a comedy than a science fiction show. Douglas Adams didn't write it to rival Arthur C. Clarke; he wrote it as a funny documentary of the human species.”

Each Vagon performer wore a webbing undersuit with belt and shoulder harness that carried the weight of a hollow latex body, with an aluminum backpack and spar that extended over the performer's head. Animatronic heads hung on a gimbal in front of the performer, with handlebars on the interior to control head and neck movement. Creature performer coordinator Peter Elliott guided Vagon performers, who navigated the set using a



After more than two decades in development, author Douglas Adams' science fiction satire The Hitchhiker's Guide to the Galaxy— popularly dramatized on radio and television – made the leap to motion picture screens.

video camera inside each creature's nose, while external puppeteers performed animatronic heads off-camera via radio control and the Henson Performance System. The puppeteers' right hands controlled jaw motion, while their left hands controlled more detailed motion, motivating 35 computer-controlled servomotors in the creature's face. Spindly Vogon arms were either left to hang dolefully by the creatures' sides, or were operated by triggers from behind the elbow, with puppeteers controlling adroit arm motions from behind the bulky bodies. Closeups were also achieved using Vogon hand gloves.

Backed by a mostly British crew, director Garth Jennings realized the idiosyncratic epic by favoring in-camera trickery and strategic digital effects. Visual effects supervisor Angus Bickerton and visual effects producer Andrew Fowler oversaw the effects initiative – interweaving Cinesite digital work with miniatures and animatronics – bringing Vogon motherships to planet earth and catapulting Adams' bewildered earthling hero into picaresque galactic adventures.

Vogon commanders Jeltz and Kwaltz had hero animatronic heads affixed to common bodies outfitted in rubberized foam costumes fabricated by Henson. An army of 50 Vogon characters included 15 soldiers, 20 'backbencher' acolytes and a scattering of minions. "The backbenchers were old chuffers," commented Henson creative supervisor Sharon Smith, "typical politicians in pinstripe jackets, but terribly worn and filthy. The soldiers resembled S&M gimp suits. The minions were a bit more 'mincey' and Scrooge-like. We gave the females little pinafore dresses. They were beautiful!"

Vogon ships, grouped in a symmetrical pincushion array around the globe, destroy earth. The formation was revealed by Cinesite in a series of reverse jump cuts that began with Arthur Dent and his alien companion Ford Prefect (Mos Def) hitching a ride via an energy beam, photographed in a down angle from a Super Technocrane 40 feet above the actors on location in Hertfordshire. Sequence supervisor Jan Tönsmann nested the image into a higher-angle view, shot from a cherry-picker crane at another location representing Arthur Dent's demolished house, then created wider angles using imagery derived from large-format aerial reconnaissance photographs and online satellite imagery. Tönsmann extended town and countrywide views and beyond with layers of clouds and atmospheric effects. "Each layer was nested within the previous one," said Adam McInnes. "There were dozens of 3D projections and we didn't have the luxury of hiding transitions with motion blur because the pullback was done in jump cuts; so as we introduced layers we mixed the edges and watched continuity very closely on each cut."

The journey ends at the Vogon ships with the camera kissing the surface of one megalithic craft. The extreme closeup required enhancement of a miniature element using a high-resolution 3D model with a second pass of projected textures. The remainder of the fleet and views of earth's final gasp were created entirely digitally. "Garth wanted a huge buildup to anticipate a calamitous explosion like the Death Star in *Star Wars*," stated McInnes, "but then, of course, there is just this little 'phut' as earth disappears." Cinesite rendered the anticlimactic effect using particle animation designed specifically for the event. "The TDs came up with effects that took the projection of the globe, separated it into land mass, water and clouds, and had particle simulations doing all sorts of clever things. We ended up with a 12-frame animation, which we then squeezed to six."

After the explosion, the camera tilts up into space to reveal a flat, dark metallic object, The Hitchhiker's Guide, drifting into view like the monolith in 2001: A *Space Odyssey*. Composited by Cinesite, the shot featured a 3D model of the Guide generated by Shynola, based on scans of an

Asylum prop. “The Guide went through a long design process,” remarked Asylum project supervisor Mark Mason. “There was an iPod look, a G4 look and a Swiss Army knife look with a glossy red cover and metal edges. We went very simple in the end — just a book that was a bit bigger and chunkier than a CD.” Machined out of aluminum, the Hitchhiker’s Guide was painted satin black, then distressed to create a dog-eared appearance. Asylum constructed three versions of the prop: one closed, for carrying; one hinged for opening, with translucent screens illuminated from the edge by small LED bulbs; and a locked-open version with a solid illuminated bluescreen designed to fill the widescreen format. In addition to the floating CG Guide, Shynola generated digital animation to illustrate the Guide’s computer readouts, first seen in a 90-second animated sequence accompanied by British comedian Stephen Fry’s droll spoken commentary.

Arthur and Ford are ejected into space and transported into the *Heart of Gold*, a gleaming white ship resembling a porcelain teapot. Director of photography Igor Jadue-Lillo filmed ship interiors on a three-tiered set built at Elstree, while exteriors were realized digitally. “In our first discussions,” recalled Angus Bickerton, “Garth said he liked the textures of old optical and miniature effects. But the concept for the *Heart of Gold* as a shiny, reflective white sphere would have been a nightmare to shoot as a motion control miniature — it would have been like a glass ball reflecting everything in the studio. It also would have given us less flexibility in postproduction. For all those reasons, we decided to do it in CG.”

Working from production blueprints and conceptual designs, CG supervisor John Neill and sequence supervisor Simon Maddox oversaw construction of the digital *Heart of Gold*, creating a sense of scale in the reflective hull by introducing Space-Shuttle-like panel lines, subtle weathering and detailed lighting. “Whenever we did big 3D renders on this show,” observed Matt Johnson, “rather than just light a model and render two or three CG passes, we set up a pipeline to generate up to 20 passes. The 2D artists then combined those passes, tweaking all the levels; so if the director wanted the spaceship to be shinier, we could quite easily tweak the specular pass. It gave us a lot more control over the look of any CG object within the composite.”

The *Heart of Gold* was built up of 10 to 15 passes and included a 3D model of the cockpit set, used to cast dimensional CG reflections on the windshield. To give space scenes an added in-camera feel, Angus Bickerton obtained lenses used in photographing the *World War II* drama *Saving Private Ryan* and shot practical lens flares and optical aberrations. Cinesite then utilized the elements to introduce chromatic effects, red channel fringing and halation into CG spaceship shots.

The teapot motif followed through to a dainty blue trim around the *Heart of Gold*’s nose and a similar decoration on the ‘infinite improbability drive,’ a series of conical counter-rotating rings



Jeltz, commander of the fleet sent to demolish earth, tortures hitchhikers Arthur Dent (Martin Freeman) and Ford Prefect (Mos Def) by reading Vogan poetry. Jim Henson’s Creature Shop created Jeltz and an abundance of other alien beings inhabiting Adams’ universe as entirely animatronic creations. Each Vogan performer wore an undersuit and harness that carried the weight of the corpulent body. An animatronic head hung on a gimbal in front of the performer, allowing for the manual control of head and neck movement. External puppeteers orchestrated facial articulation via radio control and computer-controlled servomotors.

recessed in the rear of the craft. “Improbability drive was supposedly invented by a man studying Brownian motion in a cup of tea,” explained Bickerton, “so they gave the ship a Wedgewood china color scheme. An artist by the name of Turlo Griffin spent two months hand-drawing a frieze showing the evolution of the drive. The engine also hinted at a roulette wheel, because every time the *Heart of Gold* engaged improbability drive, it was pure chance where and how the ship would materialize.”

Infinite improbability drive is first seen in action as the *Heart of Gold* picks up Arthur and Ford, by chance. The director had suggested that the jump in and out of ‘improb space’ look something like a slot machine, cycling very quickly through a number of shapes before hitting its final form. “In the book,” commented Bickerton, “Adams described the ship as passing through every atom in every point in the universe all at once; and so I imagined it as a very complicated effect, expanding, scattering and reforming — but Garth kept saying, ‘No, no; it’s going to be really simple.’”

Working with previsualization artist Evan Davies, Bickerton devised improb drive transitions, mapping textures of the *Heart of Gold* onto successions of random objects. “We were going to have a telephone with the ship’s texture mapped onto it, then a banana, then a rubber duck — but that looked kind of strange, so we whittled it down to just banana, telephone, teapot, *Heart of Gold*.” *Improbability* jumps adopted random themes, the slot machine theme involving two cherries, a lemon, half a melon — each object shrinking to a point in three frames, then zooming out to reveal the next, with flash frames and practical lens flares in between.

An element shoot at Bray Studios further streamlined the improbability drive effect. “We were planning to build the improbability objects in 3D,” Andy Fowler explained, “but then, as we were budgeting the shots, I suggested that we just shoot real objects, instead. So Angus shot a real rubber duck, a real anvil, a real pipe against bluescreen, then popped between each one. It was extremely funny, and it fit the movie perfectly.”

One of the more improbable transitions temporarily transforms the *Heart of Gold* into a knitted version of itself. Early experimentation for the scene involved a miniature effects rig constructed by Bill Pearson’s team — a four-foot-diameter mechanical frame shaped like the *Heart of Gold*, outfitted with sweaters, which writhed on bladders and hand-cranked devices. The team finally settled on a more basic visual. “We ended up buying a ball of wool and sticking two needles in it,” related Fowler. “Angus shot it flying to camera, unthreading, and composited it flying through space.” The interior of the ship, similarly transformed, was realized in stop-motion. “Sean Mathiesen, who was a previz



A Vogon councilor, awaiting wardrobe, in the London studio of the Henson creature shop, with fabricators Giselle Grant and Katherine Flemming. Henson created 50 Vogons for the film, as well as distinctive Vogon wardrobe to represent the societal strata of the bureaucratically obsessed beings. Costumes were fabricated out of sheets of custom-formula rubberized foam, which Henson produced in immense quantities. Fabricators tailored the material to fit the seven-and-a-half-foot-tall creatures and added details to suggest the Vogons’ lack of regard for personal appearance and good hygiene.

artist on the show, supervised the sequence as a little project with second unit director Dominic Leung. They had knitted puppets made and armatured quite cheaply, then animated them on doubles. It was not perfect animation, but that was the charm of it.”

Arthur and Ford briefly materialize on board the *Heart of Gold* as talking sofas — mechanical props with articulated seat cushions and arms created by Asylum — then are met by Marvin, a diminutive robot with an expansive cranium and a depressive demeanor. The Henson crew created Marvin as a walk-around suit, adhering closely to an art department conceptual design. “They’d found a nice little recipe for Marvin,” commented Jamie Courtier. “It had the two attributes that were the worst things for a depressive to have: absolute perfection and absolute cuteness. We only had to modify it slightly as we proceeded with the build.”

Marvin suit manufacture proceeded by sculpting clay over a fiberglass lifecast of robot performer Warwick Davis, then molding, casting and tooling highly polished, lightweight fiberglass pieces. Senior fabricator Nicola Tedman generated an undersuit that supported fiberglass pieces interspersed with neoprene gaiters at the body junction points. “The hard nut to crack,” observed Courtier, “was the weight of Marvin’s head. We built the head out of extremely lightweight fiberglass; but, at 28 inches across, I was concerned that if Marvin fell over, or a rigger knocked the head, the leverage would be so great it could seriously injure Warwick.” The head incorporated halogen lights in Marvin’s eyes, heat extraction funnels, a pinhole camera, video monitor and two-way radio to enable Davis to communicate on set. To support the weight of the equipment, Henson built a mechanical gimbal to circumnavigate Davis’ head, rigged to prevent Marvin’s head from rocking back further than Davis’ spine would allow, while distributing weight around the actor’s body.

Polished, primed and painted with white pearlescent BMW automotive paint, then loaded with battery packs, the completed suit weighed 56 pounds — three-quarters Davis’ body mass. “When Warwick first got into the finished suit in rehearsals at Elstree,” Courtier recalled, “our hearts stopped. It had become quite heavy with all its paraphernalia, and it was difficult for him to move. This, of course, was not something we wanted to learn just before going into a major motion picture! But it was a testament to Warwick’s stamina, endurance and professionalism that he overcame that. It was like weight training. He acclimatized to the suit quite quickly and we never had a problem with it.”

Courtier and Peter Elliott helped Davis develop Marvin’s body language, and implemented a special rig for a scene in which Marvin was required to run across a rocky planet surface, shot on location in Wales. “Warwick had learned to manage the suit for



Henson project supervisor Jamie Courtier moistens the lips of Vagon second-in-command, Kwaltz, while art finish supervisor Melissa Lenihan attends to the character's hair. Courtier guided Vagon performances with creature performer coordinator Peter Elliott, while Vagon performers navigated the set via a live video feed from a camera hidden in each creature's nose. To maintain the spontaneity of Vagon performances on set, Henson puppeteers rehearsed lipsync to prerecorded voice tracks, then, during shooting, delivered lines live while performing radio controlled mouth movements. Actors

all of Marvin's day-to-day events," stated Courtier, "but running in a quarry was something that he couldn't do. We were scratching our heads about

provided final Vogon line readings during postproduction recording sessions.

how we were going to achieve that shot, wondering if we were going to have to fall back on CG, until Peter Elliott suggested using an early prototype version of the suit." Built to test joint articulation, the lightweight prototype was roomy enough to accommodate Elliott standing inside with his head pushed up against the top of the robot's cranium and his hips at Marvin's shoulders. "Nicola Tedman made a soft fabric suit that held the panels together so Marvin's arms just hung there; but, for long shots, you couldn't tell it from the hero suit." With the exception of one digital rod-removal shot, all of Marvin's scenes were realized practically.

Marvin's owner, playboy president of the galaxy Zaphod Beeblebrox (Sam Rockwell), also necessitated experimentation to determine a viable approach to depicting the character's requisite second head. Early in preproduction, Jon Hollis devised a test with Garth Jennings that negated the need for a potentially ungainly second head sitting, parrot-fashion, on the character's shoulder. "The idea was that this second head had been split off as a bad-tempered alter ego," related Angus Bickerton. "Head 1 was ashamed of Head 2 and kept it hidden beneath a pashmina scarf around his neck. But in stressful moments Head 2 would pop out, as if on a Tourette's Syndrome impulse. That made Zaphod more manageable to shoot and budget."

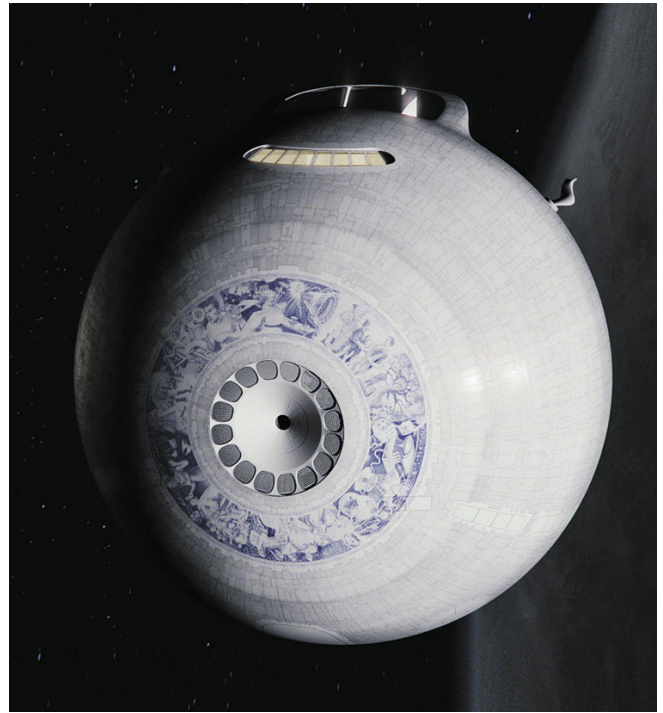
Jennings performed the Zaphod test, delivering Head 1's performance to a locked-off camera and then suddenly throwing his head back. He then performed Head 2, burying his head into his collar and popping up into view. The second head was then composited into the first, creating the illusion of a talking face in Jennings' neck. "They were planning to use the effect for Head 2's appearance," said Bickerton, "then cut away and come back to the actor wearing a prosthetic on the top of his head, to which we would potentially add eye blinks and facial movements." Henson created a silicone prosthetic 'face hat' with wig and beard for Sam Rockwell to wear in 'Head 2' mode, but this was used sparingly. "What struck me early on was that whoever was going to play Zaphod was going to want the freedom to move around and, therefore, the idea of doing one take of Head 1 and then repeating it as Head 2 wasn't going to work. There was no way we were going to be able track to and merge two takes every time in 2D."

The filmmakers, instead, intermingled 2D head reveals strategically with 3D effects. "We shot Sam wherever Garth wanted on set," Bickerton explained. "We knew there were going to be moments when Sam and Garth would say, 'Oh, it would be really cool if he popped up here,' so we let that happen. Sam threw his head back revealing tracking markers on his neck and, wherever possible, we shot a reference take of him performing Head 2. Editor Niven Howie and visual effects editor P. J. Harling then used that to crudely overlay his performance on the Touch Lightworks system, to get a feel of how it would work."

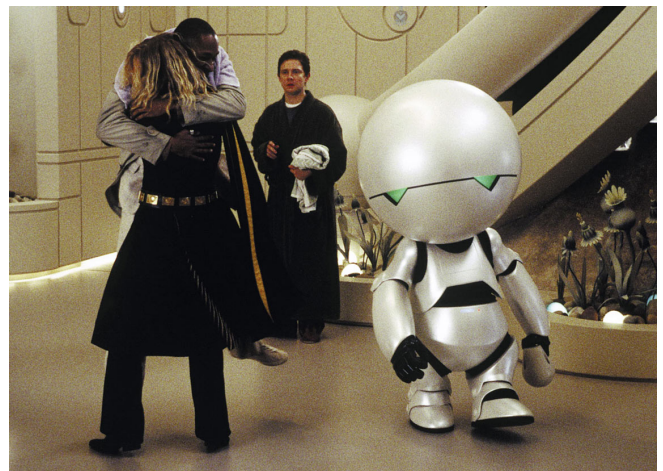
For less mobile head reveals, Rockwell performed second-head performances against bluescreen, aligning himself to video playback. Cinesite then tracked and composited those elements in 2D. For more dynamic appearances, Rockwell delivered his performance seated, his head locked in place, filmed by one 200-millimeter lens centered on his face and another shooting his profile. He was then cyberscanned in 12 key facial positions enacting vowel shapes, cursive mouth shapes and extreme facial positions. Cinesite utilized the cyberscans to create 3D Maya models of Rockwell's face, then projected the bluescreen facial footage while animating geometry to Rockwell's performance. "It was a bit like the old idea of projecting a face onto an egg," Bickerton observed. "It gave us the freedom to track the second head to anything Sam was doing."

Zaphod's second head appeared in 30 shots. The character's third arm appeared in even fewer, achieved in one shot as a Henson rod-puppeteered prosthetic arm, and all other times as a digital composite. Rockwell performed third-arm performances on set, repeating actions with his arm protruding from beneath his pashmina. Cinesite then composited the additional limb in 2D and blended the arm to the actor's body by manipulating the pashmina and a necklace around Rockwell's neck.

Arthur encounters even more exotic alien lifeforms on Viltvodle VI, a dark and polluted planet where excessive use of underarm deodorant has led to permanent smog and a religion devoted to the worship of a nasally fixated deity, the Great Green Arkleseizure. Henson's produced a broad variety of aliens for the scene, filmed in a blacked out, fog-filled stage at Frogmore Studios in north London. Cinesite provided glowing digital set extensions and generated bizarre appendages for the planet's religious leader, Humma Kavula (John Malkovich). Shot at the Masonic Lodge High Temple in London's Covent Garden, Malkovich performed the scene dressed in a robe and an ornate pair of gold spectacles. Upon removing the spectacles, Kavula reveals his eyes to be holographic



Dent and Prefect next hitch a lift on the Heart of Gold— a spherical spaceship patterned after a porcelain teapot. Cinesite created the ship as a digital model, with a Wedgwood china paint trim designed to hint at the teapot motif. An intricate frieze around the spacecraft's nose depicted the vessel's origins, and included representations of Douglas Adams and members of the production team.



Inside the ship, Zaphod Beeblebrox (Sam Rockwell) greets the hitchhikers, accompanied by Marvin, a diminutive, depressive robot, created by the Henson team as a walk-around suit worn by actor Warwick Davis.

projections concealing hollow sockets. Malkovich performed the spectacle removal with bluescreen material on the inside of the lenses. Using a cyberscan of Malkovich's face, Cinesite then tracked the actor's eyes into the frames and added matte-painted pits as 3D projections.

Kavula then rises from his chair and glides across a table on a nest of tiny metallic legs that protrude from his sternum. Malkovich performed the scene seated on a mechanical dolly. "The art department built a huge snooker-sized table with a removable middle section," Bickerton explained. "We ran a track down the center, dollied Malkovich along, and then shot motion-encoded repeat passes and a couple of lock-offs of the completed table."

Garth Jennings ran his fingers through Kavula's plate of food to create interaction of the legs. Cinesite then roto-scoped Malkovich's lower half, patched in the center section of the table and modeled insect-like legs in Maya, with one gimpy leg. "Garth didn't want Humma's legs to walk with perfect movement," noted McInnes. "He wanted them to be more like a device that special effects had slammed onto the table on the day, and was only just about working." Animator Sally Goldberg developed Kavula leg animation in Houdini, creating complex walk cycles and a quirky gait with an odd leg that scraped and jittered as it walked. For shots after the legs have telescoped to the floor, Malkovich donned a floor-length cape and glided about the room with the assistance of a camera dolly.

The next alien port of call brings Arthur, Ford and Zaphod to the Vogon home world on board the *Heart of Gold*'s spherical escape craft, the 'Hogpod.' Cinesite animated a CG version of the Hogpod to careen comically under Arthur Dent's inexperienced control. Asylum created a practical Hogpod interior and full-scale exterior as a fiberglass construction, machined in polystyrene, laminated with fiberglass and given a Ferrari red finish with incongruous windshield wipers.

Vogcity is revealed as a towering metropolis of concrete spacecraft docked on huge brass pins resembling a U.K. electrical socket. The cityscape



Beeblebrox prepares a cocktail, with an assist from his usually concealed third arm. Rockwell enacted third-arm performances in a second take on set. Cinesite digitally roto-scoped, tracked and composited the additional limb.



The wayward space travelers encounter Humma Kavula (John Malkovich), leader of a religious cult, who unexpectedly reveals his own anatomical anomalies. After Malkovich performed the scene seated on a mechanical dolly, Cinesite roto-scoped the actor's lower half, patched in the center section of the banquet table and added tiny scuttling insect legs.

consisted of a forest of 20 miniature Vagon ships, detailed to illustrate a lack of regard for aesthetic helmsmanship. “We were told that the Vogons were miserable pilots who would park one of these buildings by just smashing into the one next to it,” commented Bill Pearson. “So we added loads of scarring and damage.” Technicians mounted one 10-foot destroyer ship to a vertical motion control rig and filmed the massive structure descending onto its power socket. For aerial views of Vogcity, modelmakers plotted buildings on a laser grid and shot repeat passes, rearranging buildings to fill the 40-by-60-foot stage floor.



The occupants of the Heart of Gold activate the spaceship's 'infinite improbability drive' and are momentarily transformed into knitted versions of themselves. To depict the improbability drive concept – which instantaneously transports travelers to uncertain destinations and rematerializes them in improbable forms – Garth Jennings called for the Heart of Gold to transform into a rapid-fire series of random forms. The visual effects team shot an array of objects for the scene, including a ball of wool. Cinesite composited the various objects into CG space environments, with zoom and flash-cut effects. For the knitted segment, miniature armatured woolen puppets were animated via stop-motion.



A crowd of pan-dimensional celebrants gathers around the supercomputer Deep Thought. Cinesite generated the crowds using elements of 50 extras filmed in four configurations, projected onto transparent digital cards to populate the terrain.

For street-level shots, miniatures were grouped with 1/500-scale background buildings, 1/100-scale foreground buildings and extreme closeup sections at 1/10-scale, including a two-foot-long motorized Vagon tram, with Vagon driver, street lamps and overhead power cables, all shot as a bluescreen element. Cinesite converted previz into Maya, deriving data for Milo motion control moves, then rotoscoped miniatures and layered in matte-painted elements. “We did a lot of painting and warping to make some of the miniatures look even bigger than they were,” Matt Johnson observed. “The director had specific ideas about how towering he wanted Vogcity to be, so we corner-pinned the miniatures and warped them to make them look even larger. In the backstreets, we rendered 3D camera data based on motion control moves and replicated background layers to create long, canyon-like streets. We then added 2D atmosphere, light beams and layers of mist to impart a sense of this grungy city.”



Miniature Deep Thought elements were built by the model team – supervised by Bill Pearson – which employed an inversion-vacuform technique to create detailed textures, with compound curves sculpted in clay. Modelmakers Vincent Jenkins and Alan Brannan apply spray glue and colored powders to detail the burnished gold surface.

The *Heart of Gold* next arrives at Magrathea — an arctic planet wreathed in cloud — and accidentally triggers the planet’s defense mechanism, which releases a pair of thermonuclear missiles. Bickerton shot aerial plates of rushing clouds for the sequence. Senior compositor Denis Sclan and 2D sequence supervisor Andy Robertson layered in and warped matte paintings and digital projections to enhance the footage, adding CG missiles with particle animation smoke trails.

To evade the missiles, Arthur activates improbability drive, causing the missiles to transform into a sperm whale and a bowl of petunias. Bickerton shot the petunias as a practical element, hung inverted from a wire before an orange screen to allow Cinesite to key mattes from the green and purple plant. The Henson team fashioned the whale as a 14-foot-long urethane-skinned animatronic. “Garth knew he had the option of CG,” said Jamie Courtier, “but he wanted to keep the whale in a quasi-real world.” The whale was mechanized with body, tail, fin and eye motion. Physical effects introduced wind and mist streaming past the whale for the bluescreen shoot. Cinesite then composited elements, imparting a sense of movement by multiplaning clouds and adding camera shake with intermittent lens flares.

The whale impacts the frozen planet with an atom-bomb-sized explosion of snow, produced as particle animation, that balloons up behind a rocky outcrop. Production shot Magrathea’s surface at Shepperton Studios on a 90-foot-square set ringed by bluescreen; Cinesite extended the environment by multiplaning layers of digital matte paintings.

Through a dimensional portal, Zaphod leads the *Heart of Gold* occupants to a planet glimpsed earlier in the film as archival footage. The planet is first seen as a tropical rainforest, home to a matriarchal supercomputer, Deep Thought, perched atop a pyramidal temple. David Early and sequence supervisor Patrick Zentis generated the jungle using foreground elements of foliage shot against

bluescreen, layered with digital matte paintings of treetops and mountains. The jungle was brought to life with fog, sunbeams and clouds, with warping and moiré effects adding movement in the trees.

For closeups of the temple, production built a gateway and steps leading up a truncated pyramid, backed by bluescreen. Deep Thought was realized as a 1/24-scale miniature resembling a home computer resting its monitor in its hands. Modelmakers built Deep Thought using inversion-vacuformed panels combined with compound curve pieces sculpted in clay, and detailed the surface with vented textures colored with a gold powder paint-additive used on the Elstree set. Modelmakers equipped the supercomputer's facial area with a single offset mechanical eye, with a cable-operated brass iris, backlit, and a larger version for closeups. Cinesite added an animating graphic to Deep Thought's mouth slot by converting a Wav file of its dialogue — voiced by Helen Mirren — into pulsating graphic-equalizer-style color bars.

Seven and a half million years later, Deep Thought is revealed in a deforested environment filled to the horizon with crowds gathered in anticipation of the supercomputer's answer to the meaning of 'life, the universe and everything.' The production filmed a gathering of 50 extras for the crowd, grouped in four configurations against bluescreen. Composer Carlo Scaduto then set up 3D cameras in D2 Software's Nuke and projected elements onto 4,000 transparent digital cards to populate the terrain. "Carlos created huge vistas of cards," explained Matt Johnson. "He photographed them in perspective, did a lot of time-slipping and grading through the crowd, then fed that into Shake where he combined a matte-painted background with bluescreen foreground people and the Deep Thought miniature."

Ten million years later, Zaphod and friends find Deep Thought watching television within a barren environment, constructed from matte paintings of deforested terrain and gloomy skies. The miniature was dirtied down with spray adhesives and colored powders, and was redressed with jungle vines.

Intercutting Zaphod's visit to Deep Thought, Arthur Dent embarks on his own excursion through Magrathea's portal in the company of a wizened sage, Slartibartfast (Bill Nighy), who leads the earthman to a mechanical cart. Asylum built two quarter-ton steel carts for the sequence, rigged to ride on air bearings driven by a chain that fed around four cogs on the studio floor.

The cart thrusts Slartibartfast and Arthur through a launch tube into a vast chamber where technicians are busy assembling worlds in the Magrathan planet factory — a gargantuan production line of zero-g machines crafting designer planets for high-paying clients. Previz outlined the sequence from launch tube to a tour of the factory to journey's end at 'Earth Mark 2' — a replica of Arthur Dent's home



The Heart of Gold's escape craft, the 'Hogpod,' makes an emergency maneuver to escape Vogcity — capital of the Vogon homeworld. Cinesite generated aerial and spacebound shots of the pod using a multilayer rendering and compositing technique to allow variations in surface reflections under differing lighting conditions. For location shooting and actor interaction, Asylum Models and Effects fashioned an interior set and a full-scale exterior of the tinycraft. Cinesite generated Vogcity environments using

planet, as it was moments before its destruction, commissioned by Deep Thought. “The previz flowed brilliantly,” said Angus Bickerton. “We just had to fill

digital mattepaintings and set extensions to enhance a large miniature.

in all the detail with Joel Collins and concept artist Alex Fort, plotting out a route that made geographical sense.” Factory concepts included planets resembling confectionery and fluffy dice. “Garth and Joel wanted to make it fun,” remarked Andy Fowler, “but we also had to make it awe-inspiring. Chocolate planets really killed the scale. We had to work our way to where we had planets that had grand scale, but at the same time had some quirkiness to them.”

Previz, converted into Maya, served to guide a bluescreen shoot of the actors in Slartibartfast’s cart. Freeman and Nighy stood in the cage mounted to a motion base, while second unit director of photography Sean O’Dell used computer-controlled lighting to impart a sense of motion. “We didn’t use complicated motion control camera moves,” said Adam McInnes. “We used the motion base to derive perspective changes on the artists. That gave us flexibility to make changes in postproduction, taking our two subjects, or sometimes even separating them, then placing them on 3D cards in perspective to our 3D camera.”

For distant shots of the cage riding through the factory, Cinesite generated 3D models of the characters, the cage and the contraption’s spurious propulsion device. “As we cut wide,” explained Bickerton, “we see the cage is riding on an infinitely extending telescoping pole, which can stop, get picked up by another pole coming in at 90 degrees, then take them off on a completely perpendicular course. Where this pole extended from, goodness only knows, but it looked good!”

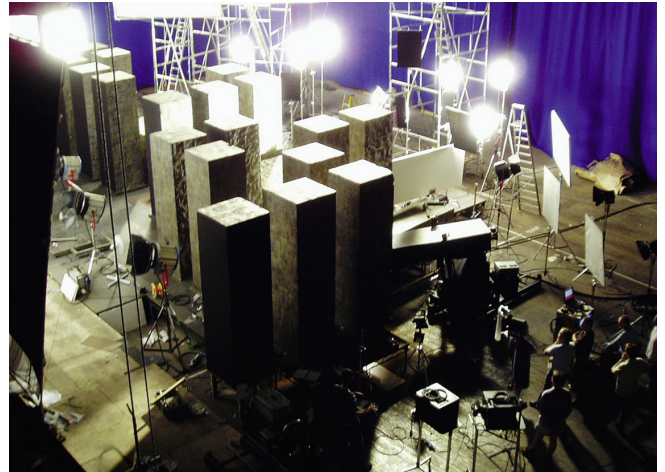
Any structures requiring perspective change — planets under construction, scaffolding, cranes and gantries — were achieved with 3D models. Composites also included practical blinking lights shot bluescreen with atmospheric effects to help tie shots together. “Anything in the distance was a matte painting,” said Ken Dailey. “Lino Khay painted all the different planets — molten planet, metal planet, Earth Mark 2 — some of which were just flat objects projected onto spheres to create a sense of movement as you’re going by. He also created texture for the far wall of the planet factory, with a delicate tracery of lights to create a vast sense of scale within this enormous space.”

Partway through the sequence, Slartibartfast’s cage swoops low over a craggy moon in the shape of a human head with a slightly bulbous nose — a 3D model of Douglas Adams, based on a cyberscan of the author’s head made for a 1998 computer game, mapped by Cinesite with matte-painted rock textures.

The cage descends to Earth Mark 2 and passes Australia’s Ayers Rock, where a Magrathean technician is adding final touches to the red sandstone finish. The production shot the Magrathean performer on a gray rocky texture backed by bluescreen. Cinesite then used a large-format 2D image of Ayers Rock and blended the two, rotoscoping the performer and adding matte-painted textures by David Early.

Slartibartfast then skims oceans, flies by the white cliffs of Dover and traverses green countryside, composited by sequence supervisor Christian Zeh who blended live and 3D cage elements into aerial shots and footage shot by Bickerton and model unit director of photography Rick Mietkowski. “Earth Mark 2 was a real ‘Frankenstein’ for compositing,” Adam McInnes noted. “It brought together bits and pieces from all over. It changed enormously from the previz; so lighting on the cage didn’t always match the backgrounds, and it required a lot of work reducing strong lighting from one side, increasing light on the other side, re-lighting in 2D.” The two-and-a-half-minute sequence ends with Arthur deposited back where he began, at his country cottage. Actors were shot riding the cage mounted to a forklift on location in Hertfordshire.

Arthur is reunited with Zaphod and friends inside his rebuilt house, and also makes the acquaintance of a pair of talking mice — Lunkwill and Fook — the physical embodiment of pan-dimensional beings who built Deep Thought. A-Z Animals Limited trained and furnished live mice for the scene, filmed at 48 frames per second to slow down twitches, and photographed as bluescreen inserts for composites of the mice clambering over a precarious mechanical effects rig.



Vogcity is revealed as a forest of towering concrete spacecraft docked in monolithic skyscraper formations, plugged into upright brass pins resembling U.K. electric sockets. Bill Pearson’s team built 20 miniatures representing four-mile-high Vagon constructor ships and smaller, squatter destroyer vessels. Modelmakers clad the spacecraft with vacuform texture panels, then painted surfaces with acrylics, weathered and distressed to represent damage inflicted by inept Vagon pilots. Aerial views were plotted using lasers to map a grid on the Shepperton Studio stage floor. Street-level views were achieved by grouping variously-scaled buildings – background, midground and foreground -- and shooting in forced perspective with motion control.

Mice required minimal digital assistance to create an impression of their speaking. “We were skeptical that live mice could be trained to give us everything we needed,” admitted McInnes, “but Garth was adamant about shooting them live, and we got nearly everything in-camera.” As a safety backup, Cinesite modeled a 3D mouse with full skeletal system, muscle rig and fur shader, but the model was used only for muzzle replacements. “For ease of compositing, we used most of the CG head, then put back the live eyes and ears, and sometimes the real whiskers. We projected the live-action onto the 3D mouse face, and then we grew 3D fur to blend into the real fur.”

Escaping the mice, Arthur, Zaphod and company are confronted by a crowd of angry Vogons gathered outside. Henson’s provided the full complement of its animatronic creations for a bumbling laser shootout. Cinesite multiplied the Vogons to an even larger crowd, replicating bluescreen elements in Maya and Shake for high angles of the creatures tumbling like dominoes across the countryside, paralyzed en masse by Marvin’s terminal depression.

The film concludes with Arthur departing Earth 2 in the *Heart of Gold* with his newfound friends, heading off towards a restaurant at the end of the universe via a final improbability drive jump. “The ship zooms towards camera,” related Angus Bickerton, “jumps into improb drive, cycles through five objects — and then, the last object before it disappears is Douglas Adams. We modeled it from the computer game cyberscan of Douglas’ head, which his business partner Robbie Stamp helped us find, and we made that the final object — very, very briefly! I was reticent to suggest the idea to Garth because I thought it might be too cheesy; but it worked quite well. Then we cut to the final card, ‘For Douglas.’”

The cinematic romp through Adams’ vision of a universe teeming with absurd and infinite creations required a considered and flexible approach to realize the complex catalog of visual effects. “Most effects shows might have five or six big sequences with 80 to 100 shots per sequence,” remarked Ken Dailey. “In *Hitchhiker*, we had 30 sequences and 30 different creative styles. That required a very multi-dimensional pipeline and a very sophisticated production tracking database system. When we were reviewing shots with Garth in our 2K playback suite, the guys on the production floor could see the work updating live, and they could instantly make tweaks to the animation, modeling, textures or composites and run it back through the pipeline. That enabled us to get work done very quickly and keep the cost down.”

The production was also greatly enabled by an appreciation of the source material. “This was a home-grown project,” stated Angus Bickerton. “Its heritage can be dated back to Monty Python, and there has been very little tampering with it. I have to credit Spyglass and Disney with being especially brave in embracing the very eccentric Englishness of Douglas’ writing. They went with a



Arthur Dent is given a tour of a planet factory – a gargantuan production line where zero-gravity machines craft designer planets for high-paying clients. Production previsualized the sequence as a ride on a tiny mechanical cart shunted through the vast factory by extending telescopic poles. Cinesite elaborated on the previz to choreograph a journey through a fanciful array of planets under construction, and then combined bluescreen footage of actors riding on a mechanical motion base with 3D foreground elements and 2D digital matte paintings layered with atmospheric effects.

very English crew, and we all felt that it kept the flavor and the essence of the original. What made it so enjoyable was that we had great material to start with. Garth understood Douglas' sense of humor, and he recognized that making this movie didn't have to cost \$200 million."

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